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Environmental Laboratory

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Abstract: The future quality and quantity of water for Los Angeles, CA, depends on effective environmental management of both water and land use in Owens Valley. Long-term environmental monitoring will be used to assess progress towards attaining sustainable restoration goals. Reestablishment of native plant communities on previously cultivated lands is a major land management goal. Establishment of desired plant communities may, in turn, depend on relationships between soil microorganisms and plants. These interrelationships depend on soil characteristics affecting the microbial communities. This study was designed to provide survey information on microbial communities in soils from native and disturbed areas at ten locations spanning Owens Valley. At each location, five surface soil samples were collected along a 150-m transect through native vegetation, and ten soil samples were collected along a 300-m transect through disturbed areas. Soils were characterized by soil texture, total carbon, total nitrogen, organic carbon, organic nitrogen, leachable carbon, leachable nitrogen, carbon and nitrogen isotopic ratios, microbial community biomass, and lipid profiles of soil microbial community compositions. Analysis of variance, Tukey's test for comparing multiple means, hierarchical cluster analysis, and principal component analysis were used to show differences in soil characteristics. While native and disturbed soil samples were shown to differ in many characteristics, the largest and most frequently shown differences were related to the soil microbial communities. Total soil microbial biomass was significantly and consistently higher in native soils than soils from disturbed areas. Large and significant quantitative differences were also seen in the sterol content of soils supporting native plant and those of disturbed areas. The level of fungal sterol ergosterol was consistently and significantly higher in soils supporting native vegetation than in soils from disturbed areas, indicating mycorrhizae as potentially important plant symbionts. The presence of phytosterols and other unidentified sterols was also higher in the native plant soils. In conclusion, soils supporting native plant communities were most different from those in disturbed areas in characteristics related to soil microbiology.

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Abbreviations and Acronyms

AM	Arbuscular mycorrhizae
ANOVA	Analysis of variance
ASE	Dionex brand Automated Solvent Extractor 200
BGP	Big Pine, California
BIS	Bishop, California
BLK	Blackrock area, California
C	Carbon
CH_2CL_2	Diclhoromethane
CO_2	Carbon dioxide
Costech	Costech (brand) ECS 4010 Elemental Analyzer
DCM	Dichloromethane, methylene chloride, a non-polar organic solvent
DSE	Dark septate endophytes
ERDC	Engineer Research and Development Center
FSL	Fish Slough area, California
GC	Gas chromatograph
GC-MS	Hewlett-Packard 6890 gas chromatograph paired with a HP 5973 mass spectrometer
GPS	Global positioning system
HCA	Hierarchical cluster analysis
HPLC	High pressure liquid chromatography
i.d.	Inside diameter
IND	Independence, California
KNN	K nearest neighbor
KOH	Potassium hydroxide
LADWP	Los Angeles Department of Water and Power
LAW	Laws, California

LOI	Loss on ignition
meoh	Methanol, a slightly polar methyl alcohol solvent
MS	Mass spectrometer
MSTFA	N-Methyl-N-trimethylsilyltrifluoroacetamide
MWH	Montgomery Watson Harza
N	Native vegetation area sample
N_2	Nitrogen gas
Nsd	Not significantly different
NIST	National Institute of Standards and Technology
PCA	Principal components analysis
PLFA	Polar lipid fatty acid
PLFAME	Phospho-lipid fatty acid methyl ester
PLS	Partial least squares
R	Revegetative area sample
Rpm	Revolutions per minute
SIMCA	Soft independent modeling of class analogy
SPE	Solid phase extraction
TC	Total carbon
Temp	Temperature
TLSN	Total leachable soil nitrogen
TMS	Tri-methyl silanization
TN	Total nitrogen
TRN	Total residual nitrogen
TSC	Total soil carbon
TSN	Total soil nitrogen
TSOC	Total soil organic carbon
U.S.	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture

USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VPDB	Vienna Pee Dee belemnite
WAAS	Wide Area Augmentation System

Preface

This report documents physical and microbiological soil characteristics from ten locations within Owens Valley, California. This baseline survey and comparison of soil characteristics was designed to detect differences between soils from disturbed areas and soils supporting native vegetation. These soil characteristics are believed to be a critical factor in successful restoration of native plants in this and other semi-arid and arid landscapes. Identification and successful engineering of soils to establish these characteristics would greatly expedite the re-establishment of desired plant communities to Owens Valley.

This study was conducted as part of Co-operative Research and Development Agreement between the U.S. Army Engineer Research and Development Center and MWH Americas, Inc. Dr. David Price serves as the ERDC point of contact.

This study was conducted by Dr. Herbert Fredrickson, Dr. Price, John Furey, Chris Foote, and Margaret Richmond. Dr. Price is the Acting Chief of the Ecological Resources Branch of the Ecosystem Evaluation and Engineering Division, Environmental Laboratory (EL). The other co-authors work in the Environmental Processes Branch of the Environmental Processes and Engineering Division, EL. The work was conducted under the general supervision of Dr. Price and Dr. Beth Fleming, Director, EL. This report was prepared by Dr. Fredrickson, John Furey, and Chris Foote. The report was reviewed by Dr. Elly Best (Environmental Risk Assessment Branch of the Environmental Processes and Engineering Division, EL) and Dr. Terry Sobecki, Chief of the Environmental Branch of the ERDC Cold Regions Research and Engineering Laboratory (Hanover, New Hampshire).

COL Richard B. Jenkins is Commander and Executive Director of ERDC. Dr. James R. Houston is Director.

1 Introduction

The Owens Valley is a semi-arid valley region of California situated between the Sierra Nevada mountains to the west and the White and Inyo Mountains to the east. The effects of the Sierra Nevada on rainfall in this region are profound. The large rivers on the western slope drain into California's Central Valley and support intensive agriculture and dense populations in central California. Little precipitation falls in the rain shadow on the eastern slopes of the Sierra Nevada. Rivers originating there drain into desert valleys and then into terminal lakes in California and Nevada. Historically the rivers in this region have supported a narrow zone of riparian vegetation, adjacent wetlands, and meadows.

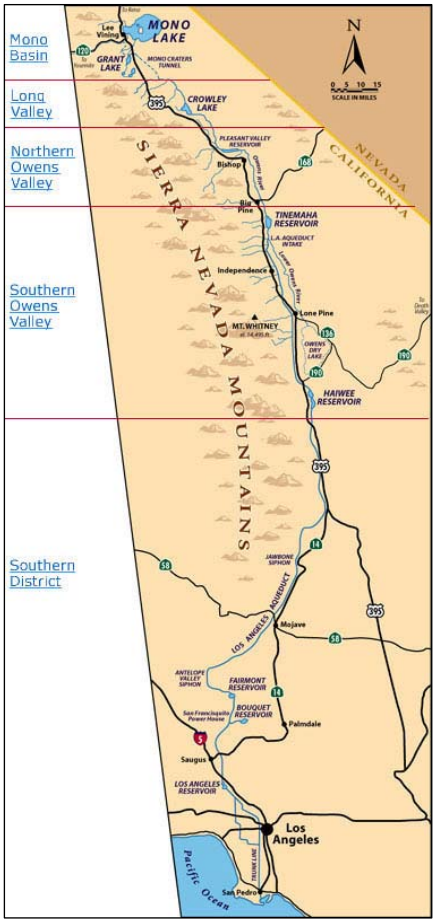

Figure 1. Map of the Owens Valley showing the different regions.

The Owens River is approximately 193 km long and drains the narrow Owens Valley, an arid basin bordered on the east by the Sierra Nevada and on the west by the White and Inyo Ranges. The river originates in the Sierra Nevada in southwestern Mono County, approximately 32 km south of Mono Lake and 40 km east of Yosemite Village. It flows southeast across the Long Valley Caldera, passes through Lake Crowley reservoir, and then descends through the 16-km Owens River Gorge, emerging at the north end of the Owens Valley north of Bishop. In the area around Bishop, it is diverted through ditches to irrigate the surrounding farming region. It flows south-southeast past Big Pine. Approximately 16 km south-southeast of Big Pine, much of the river has been diverted into the Los Angeles Aqueduct. The remaining river flows through the southern valley, flanked by the Los Angeles Aqueduct, past Lone Pine, entering Owens Lake at the southern end of the valley.

In 1904, Fred Eaton and J. B. Lippincott identified the Owens River as a potential source of water for the rapidly growing city of Los Angeles. They began purchasing land in the Owens Valley in 1905. William Mulholland succeeded Fred Eaton as the superintendent of the Los Angeles City Water Department and championed the construction of the first Los Angeles Aqueduct. Construction of the aqueduct began in 1908 after approval by the House of Representatives and President Theodore Roosevelt. It was completed in 1913. A second aqueduct in the region was completed in 1970, and groundwater began to be pumped out of the Owens River Valley.

Water is a vital natural resource, and where water is limited, control of water rights can be a hotly contested issue. More than 24 years of litigation between Inyo County, which contains most of the Owens Valley, and the Los Angeles City Department of Water and Power (LADWP) over the pumping of groundwater from the Owens Valley and its export to Los Angeles has recently been settled. This settlement calls for a large-scale restoration of the Owens Valley. The lower Owens Valley conservation area is 65 miles long and stretches from the west slope of the White and Inyo Mountains to the eastern slope of the Sierra Nevada and includes the now-dry Owens Lake and the valley around Independence, CA.

Portions of the Owens Valley were cultivated during the late 1890s and early 1900s, some of which were abandoned following the purchase of the land by LADWP. A goal of the LADWP is to return these abandoned croplands to native vegetation. The re-establishment of plant communities

may, in turn, depend on the re-establishment of relationships between soil microorganisms and plants. These relationships are not fully understood but appear to be particularly important in harsh environments such as the semi-arid Owens Valley.

The soils of the Owens Valley are largely derived from erosion of the surrounding bedrock mountains (Danskin 1998). During the Quaternary Period, Bishop and Owens Lake acted as independent loci for deposition because they were separated by the narrow valley, and eroded blackrock and basaltic flows and cones accumulated in these narrows. Lakes were located at both Owens Lake and Bishop at different times during their geological evolution. The present soils reflect this history and have been described using three models (Miall 1984) that depict specific depositional patterns that interrelate and provide a means to subdivide the heterogeneous valley-fill sediments into generalized geologic units with similar lithologic characteristics. These are 1) alluvial fan to fluvial and lacustrine plain to trunk river; 2) alluvial fan to lake; and 3) alluvial fan to trunk river to lake margin with localized river-dominated delta.

The vegetation in the Owens Valley is limited by the arid to semi-arid conditions, the high-salinity soil, and the intermittent presence of a shallow water table. Nonetheless, over 300 plant species have been described in the valley. Many plants here were first described as phreatophytes as they were thought to derive their water from roots in the saturated zone of groundwater (Meinzer 1923). Many plants are now thought to derive their water from infiltration of direct precipitation, capillary action from the saturated zone, and overland flow (Groeneveld 1990). Many plants that are apparently able to survive extended dry periods (2–3 years) exhibit similarities to other plants in xerophytic environments.

Plants native to the Owens Valley have been grouped into four communities where they most commonly occur (Sorenson et al. 1991):

- The high-groundwater alkaline meadow community is composed of *Distichlis spicata* (saltgrass), *Glycyrrhiza lepidota* (wild licorice), *Juncus balticus* (Baltic rush), *Sida leprosa* (alkali mallow), and *Sporobolus airoides* (alkali sacaton).
- The high-groundwater alkaline scrub community is composed of *Atriplex torreyi* (Nevada saltbush), *Sacrobatus vermiculatus*

(greasewood), *Chrysothamnus nauseosus* (rubber rabbitbrush), and *Suaeda torreyana* (inkweed).

- The dryland alkaline scrub community is composed of *Ambrosia dumosa* (burrobush), *Artemisia spinescens* (bud sage), *Atriplex confertifolia* (schadscale), *Atriplex polycarpa* (allscale), *Ceratoides lanata* (winterfat), *Hymenoclea salsola* (cheesebush), *Lycium cooperi* (peach thorn), *Psorothamnus* sp. (dalea), and *Stephanomeria pauciflora* (desert milkaster).
- The dryland nonalkaline scrub community is composed of *Artemisia tridentata* (big sagebrush), *Chrysothamnus teretifolius* (green rabbitbrush), *Eriogonum fasciculatum* (California buckwheat), *Ephrdra nevadensis* (Nevada squawtea), and *Purshia grandulosa* (desert bitterbrush).

Lack of water and high salt levels place a high stress burden on plants that must pull their water and dissolved nutrients in through their root systems against a high osmotic barrier. Ecto- and endo-microbial symbionts in the root zones are thought to be generally important to many plants (Koide and Mosse 2004) but may be essential to plants growing in low water and high salt soils (Auge 2001). Plants with long thin roots with long root hairs tend to have few mycorrhizal symbionts, while those with thick fleshy roots have many. Mycorrhizal fungal hyphae make extensive and intimate contact with soil particles. In return for a portion of photosynthetically fixed carbohydrates, these hyphae have been shown to transport soil water and phosphorus back into root cells. These fungal–plant associations have been shown to affect rates of transpiration, soil drying and moisture relations, growth and nutrient transport during drought, and drought resistance (Auge 2001).

Native grasses (e.g., *Bouteloua* sp.) of semi-arid rangelands of the southwestern U.S. are more extensively colonized by dark septate endophytes than by traditional mycorrhizal fungi (Barrow 2003). They are the primary root colonizers of fourwing saltbush, *Atriplex canescens* (Pursh) Nutt, a dominant and ecologically important shrub in southwestern U.S. rangelands (Barrow and Aaltonen 2001). These fungi are characteristically identified using conventional fungus staining methods, in which they appear as stained or pigmented hyphae and microsclerotia in the root cortex. Extensive internal colonization of physiologically active roots by atypical fungal structures appears to make them function much as protoplasts, without a distinguishable wall or with very thin hyaline walls. The most conspicuous

characteristics of these fungi are the unique associations that form within sieve elements and the accumulation of massive quantities of lipids. This interface suggests a biologically significant location for carbon transfer between the plant and the fungus. The continuous intimate association with all sieve elements and the cortical and epidermal cells, as well as external extensions on the root surface and into the soil, indicates that they are systemic and considerably more prevalent than previously thought.

Little has been published on the biochemistry and physiology of dark septate endophytes, but more information is available on arbuscular mycorrhizal (AM). AM fungal mycelia acquire hexoses released by the roots of their host (Bago et al. 2000, 2002) and metabolize them to lipids, mainly neutral lipids, such as triacylglycerols. Neutral lipids are transported throughout the fungal mycelium, are metabolized through the glyoxalate cycle, and probably provide the major fungal energy source. The mechanisms that regulate carbon transfer from plant to fungus are not well understood. However, AM fungal colonization affects plant carbon metabolism and the genes and gene expression that regulate this metabolism.

Storage and membrane lipids which mediate plant–fungal associations can be used as biomarkers of these associations when soil samples that contain them are analyzed. Ergosterol is an abundant sterol in most fungi and has been used to estimate fungal biomass in soil samples (Pasanen et al. 1999). More specifically, AM fungal neutral lipids usually are stored in intraradical vesicles or in spores and can make up a large proportion of the AM fungal biomass. The fatty acids of these lipids have a characteristic and specific composition. In *Glomus intraradices*, 50–70% of the fungal lipids are indicated by the 16:1ω5 phospholipids (van Aarle and Olsson 2003), which is uncommon in other groups of fungi and can be used as an AM fungal signature. This lipid and others can provide a means to screen large numbers of soil samples for plant–fungal symbionts.

This study was designed to survey physical, chemical, and microbiological soil characteristics in ten parcels of land in the Owens Valley. The first objective was to determine if soils presently supporting native vegetation significantly differed from those in previously disturbed areas and, if so, how they differed.

2 Materials and Methods

Sample Collection

The collection of 151 surface soil samples was done over a period of three days from June 21–24, 2005, in and around the Owens Valley, staging from Bishop, CA.

Figure 2. Ten sampling sites in the Owens Valley. Five surface soil samples from native areas and ten surface soil samples from disturbed areas were collected at each of the ten site. These sites, including their GPS coordinates, are described in Table A1.

Ten sites pre-selected by Montgomery Watson Harza (MWH) were sampled by personnel for MWH and the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC). Each site

was divided into two zones—Disturbed (R) and Native (N)—for sampling and data comparison purposes. The R zones were characterized and identified by such indicators as previously cultivated areas without substantial native vegetation. The N zones were characterized and identified by such indicators as a profuse amount of native vegetation identified by native species, adjacent to the R areas.

Once one of the ten sites was located by the aid of maps and a portable Wide Area Augmentation System (WAAS)-enabled global positioning system (GPS) (see Appendix A, Tables A1–A10), a visual survey of the site was made to determine the locations of the two zones within that site. Once this was done, a random spot within each zone was selected and the sampling process was begun.

At the point of the first sample within a zone, a GPS reading was taken and saved. The sample was collected with a clean shovel. The aliquot of soil was taken from the surface of the terrain to a depth of approximately 15 cm and a width of approximately 15–20 cm. The sample was placed into a clean, labeled, 3.78-L, zip-closure plastic storage bag and placed in a cooler for storage at ambient temperature until shipment. The shovel was then cleaned with anti-bacterial wipes to minimize cross-microbial contamination between samples. Then the next sample site was chosen to be approximately 30 m distance in a random (coin toss) direction wholly within the zone and the process was repeated until the required number of samples was collected in a random walk transect.

Once all 151 samples were collected, they were packed in coolers with dry ice and shipped by overnight air to ERDC in Vicksburg, Mississippi, for processing and analysis.

To help relate the results of this study to those of other studies, we list (Table 1) soils from three N zone sampling transects with the soil classifications proposed by Miall (1984) that depict specific depositional patterns that interrelate and provide a means to subdivide the heterogeneous valley-fill sediments into generalized geologic units with similar lithologic characteristics (for complete tables see Appendix A, Table A11). These are 1) alluvial fan to fluvial and lacustrine plain to trunk river; 2) alluvial fan to lake; and 3) alluvial fan to trunk river to lake margin with localized river-dominated delta. We also use this table to relate the

sampling of surface soil in the transects through native vegetation to the Owens Valley native plant communities described by Danskin (1999).

Table 1. Portion of Table A11 in Appendix A, showing the interrelation of soil classification, plant community, and type of vegetation associated with each sample.

Location	Sample Code	USGS Soil Classification	Vegetation	USGS Plant Community
IND123	N1	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N2	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N3	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N4	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N5	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N1	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N2	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N3	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N4	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N5	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
LAW082	N1	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
LAW082	N2	Qfl	*Sarcobatus vermiculatus* (Greasewood)	High-ground-water-alkaline scrub
LAW082	N3	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
LAW082	N4	Qfl	*Sarcobatus vermiculatus* (Greasewood)	High-ground-water-alkaline scrub
LAW082	N5	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub

Soil Preparation and Analyses

The soils were dry sieved and homogenized, and samples were taken for soil characterizations (Figure 3).

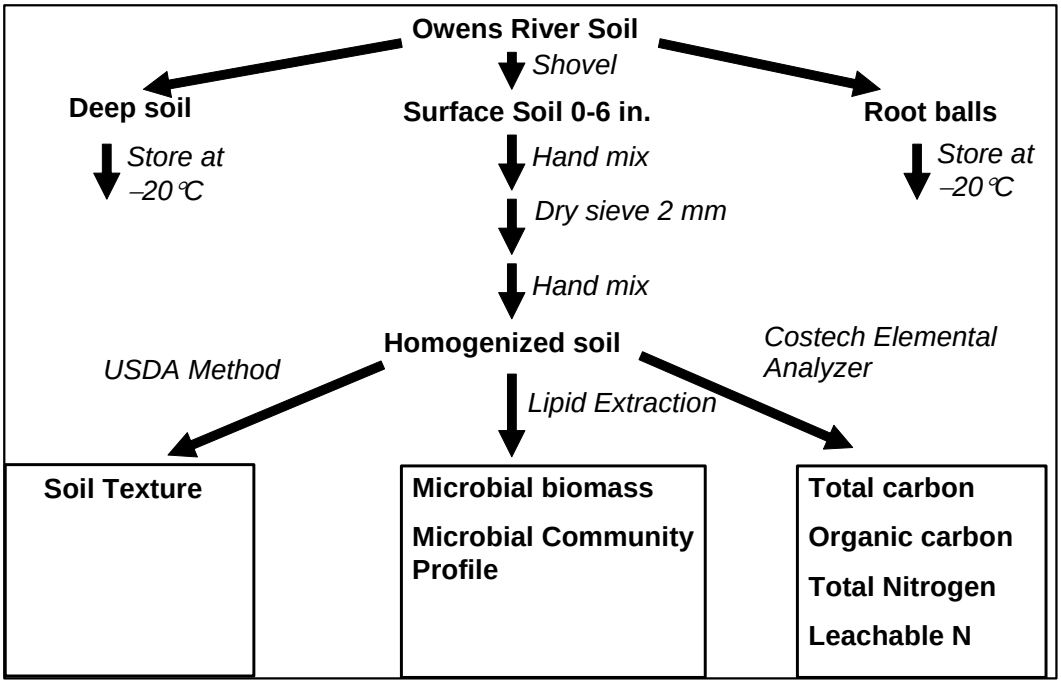

Figure 3. Soil sample process flow diagram showing handling and sampling for the various analyses.

Soil Sieving and Mixing

Once the coolers of soil samples had been received by ERDC, the coolers were placed in a walk-in freezer at –20°C. Samples were removed from the walk-in freezer and processed one cooler (15 samples) at a time. Samples were removed from the cooler one at a time and placed into a vent hood exclusively set aside for the sieving procedure. Each bag of sample was poured into a #10, 2.0-mm stainless steel sieve with a catch pan attached to the bottom; the sieve had been cleaned with a solution of 75% ethyl alcohol and allowed to air dry. The sample was then agitated until all of the <2.0-mm soil particles had fallen through the sieve. The <2.0-mm soil was then placed in a different clean, re-sealable quart- or gallon-sized bag, labeled and sealed.

The soil inside that bag was then further homogenized by rotating the bag half of a rotation horizontally and vertically by hand, at least 12 times. The sample bag was then opened, and an aliquot of the sample (~10 g) was removed with a clean stainless steel spatula and placed in a new 20-mL borosilicate glass scintillation vial with a foil-sealed cap. This aliquot was then labeled and placed in a storage box for storage in the –20°C walk-in cooler.

The classified, labeled, <2.0-mm bag was then re-sealed, while as much of the air from the bag was removed as possible. The sieved sample was archived in the cooler to be stored in the –20°C walk-in cooler. The material that was >2.0 mm was taken out of the sieve and placed in a clean, resealable quart- or gallon-sized bag, labeled and sealed. This was also placed back in the cooler.

Once each sample had been processed, the sieve, catch pan, spatulas, work surface, and sill surface of the vent hood were all washed and cleaned with a solution of 75% ethyl alcohol and allowed to air dry. Once all tools, utensils, and surfaces were dry, a new sample was removed from the cooler, and the sieving process was repeated.

Soil Analysis

Soil texture was measured by A&L Analytical Laboratories Inc. in Memphis, TN. Other bulk soil parameters, including moisture content, soil organic mass, total carbon, total organic carbon, total nitrogen, total organic nitrogen, leachable carbon, and leachable nitrogen, were determined at ERDC using a combination of gravimetric and elemental analyses. The procedures for elemental and isotopic analyses for carbon and nitrogen elemental are detailed below. Soil extracts were analyzed for soil lipids as described below.

Soil texture

Fifty grams of each sample was weighed out from the <2.0-mm aliquot, placed in a plastic bag, and shipped overnight to A&L Analytical Laboratories Inc. for soil texture analysis. The method used was the USDA Soil Texture/Particle Size Hydrometer method for percentage of sand, silt, and clay.

Moisture content, soil organic mass, total carbon and nitrogen, and total organic carbon and nitrogen

Approximately 1-g samples of sieved, homogenized soil for each of the 151 soil samples were measured into clean, glaze-ceramic crucibles that had been baked in a muffle furnace at 450°C for 1 hour, cooled in room temperature in a hood, and tared, with the weight of the empty crucible reported. The amount of soil was measured in a Denver Instrument APX-60 scientific balance and the mass recorded to four decimal places.

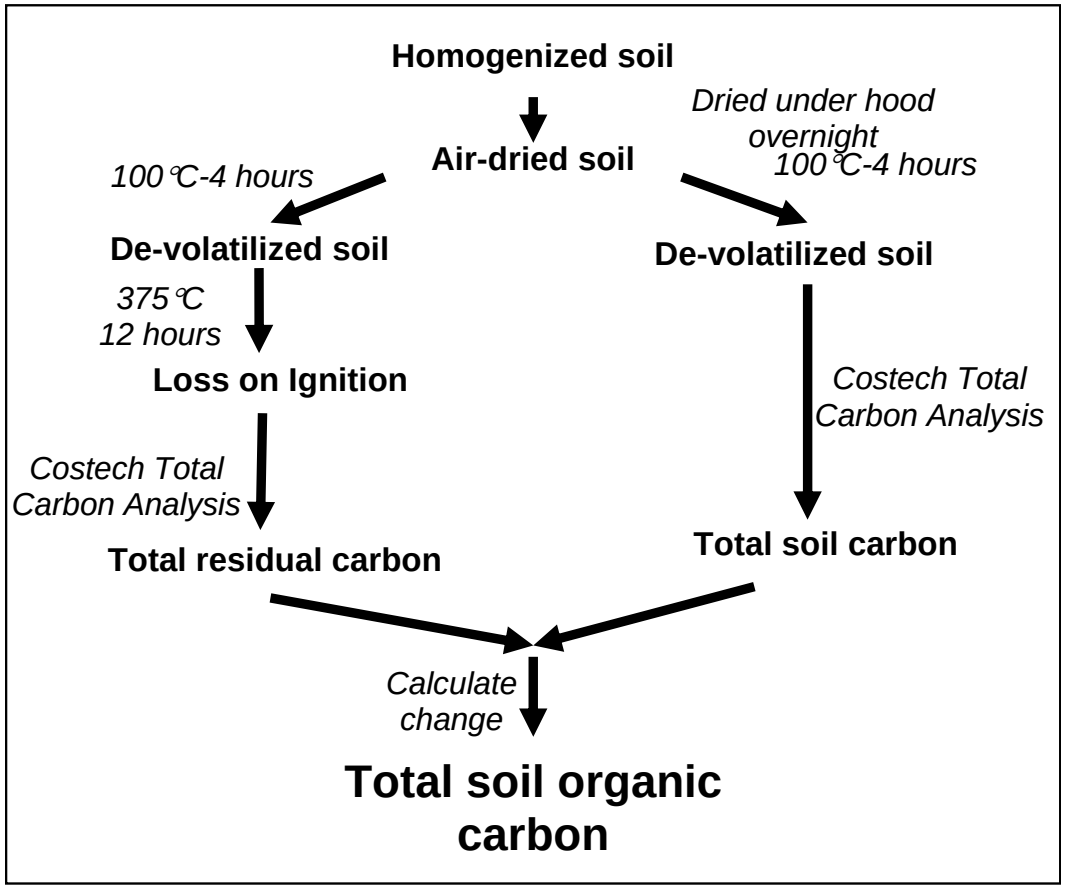

Figure 4. Procedure for determining the organic carbon fraction of the soil. Organic nitrogen was determined using analogous methods.

The crucibles with soil were then placed in a muffle furnace at 100°C for at least one hour to eliminate any interstitial water and readily volatile compounds from the soil. The crucibles with soil were then removed from the furnace and allowed to cool to room temperature. The crucibles with soil were then re-weighed and the weight recorded. The crucibles with soil were then placed back in the furnace at 100°C for another minimum of one hour, removed, cooled, and weighed again to confirm that all of the water and volatiles had been removed.

Once it was confirmed that there was no more weight change at 100°C, the crucibles with devolatilized soil were placed in the muffle furnace at 375°C and baked for two hours to combust any organic matter present in the sample. They were then removed, allowed to cool to ambient room temperature, and were weighed on the balance. They were then placed again in the muffle furnace at 375°C and left for two hours. They were again removed and allowed to cool to room temperature before being weighed for the second time to ensure that all combustible matter had been

removed. The loss-on-ignition temperature of 375°C is sufficient to oxidize the easily ignitable organic carbon (Fredrickson et al. 2004) and is more reproducible than results at 550°C, which in addition to easily ignitable organic carbon also oxidizes any black carbon (Accardi-Dey and Gschwend 2003) and often overestimates the amount of organic matter (Smedes and Nummerdor 2003). The loss-on-ignition (LOI) organic matter masses were then calculated and recorded based on the following formula:

$$LOI = \frac{weight\ after\ devolatization - weight\ after\ combustion}{weight\ after\ devolatization - weight\ of\ crucible}$$

After the LOI was calculated for each sample, the soils in the crucibles were placed in cleaned, labeled test tubes. The LOI organic matter mass measurements were reported, not the carbohydrate approximation. These soils were then analyzed for total residual carbon (TRC) on the Costech Elemental Analyzer.

Another set of aliquots of the homogenized soil samples were placed in crucibles and put through the 100°C devolatization process described above. Once these samples were removed from the muffle furnace and cooled, they were placed in a separate set of cleaned, labeled test tubes and sealed. This set was then also analyzed for total soil carbon (TSC) on the Costech Elemental Analyzer. Once the results for TSC were calculated for each sample, the difference between the TRC and the TSC was calculated, resulting in the total soil organic carbon (TSOC) mass fraction for each sample. Analogous procedures resulted in total soil nitrogen (TSN), total residual nitrogen (TRN), and total soil organic nitrogen (TSON) mass fraction for each sample.

Total leachable soil nitrogen and carbon

A few grams of soil from each sample was air-dried under a vent hood for two days. Each was then divided into two aliquots for separate processing. One aliquot of each soil was immediately analyzed for total nitrogen (TN) on the Costech Elemental Analyzer. The second aliquot of identical soil was artificially leached.

Soil was leached with HPLC-grade water using the Dionex Automated Solvent Extractor (ASE) 200. The ASE is an automated system normally used for extracting organic compounds from solid and/or semi-solid samples. Normally the extraction uses increased pressure and temperature to speed

the extraction rate. During the leaching process, only a slight increment of temperature and pressure was applied to the cell. This was done to preserve the sample and not alter its makeup.

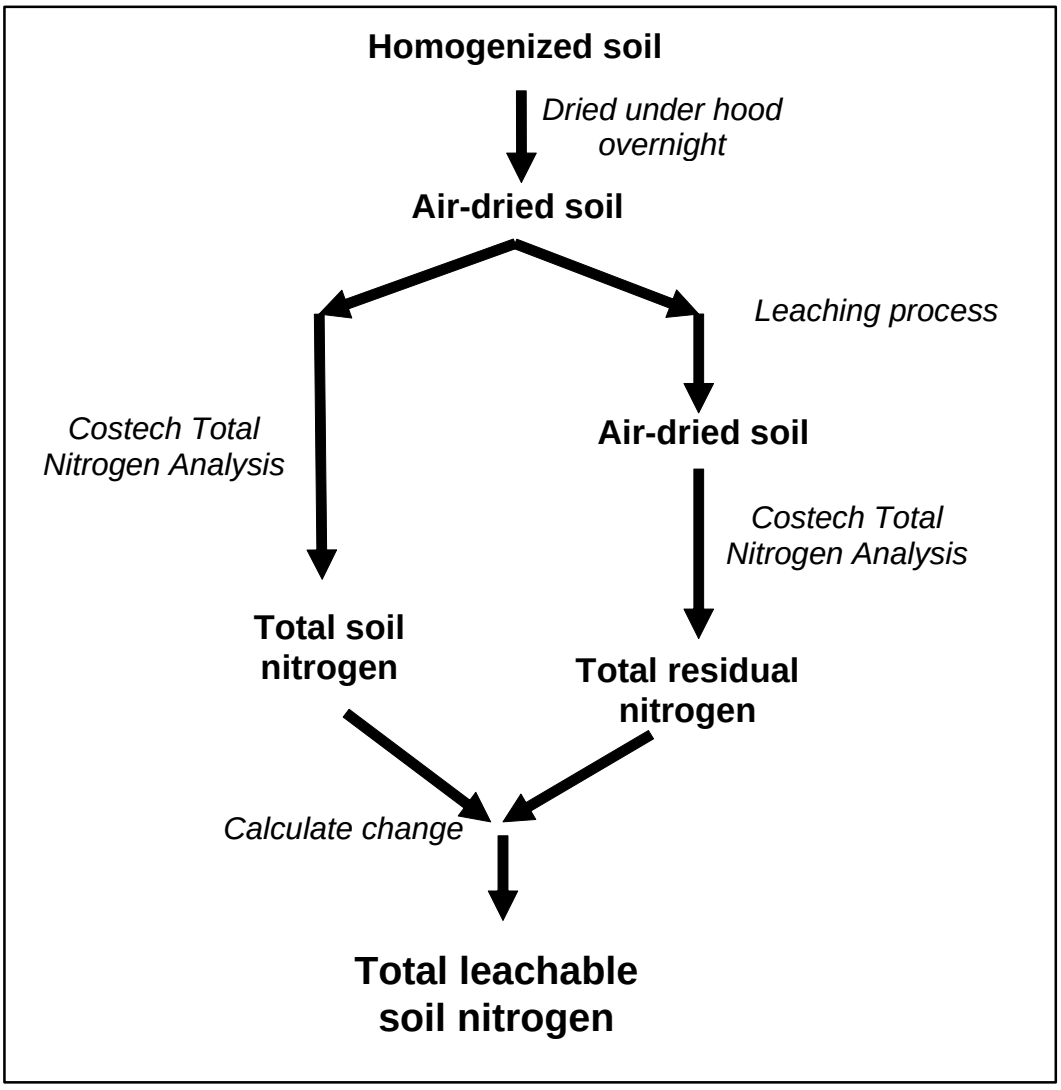

Figure 5. Procedure for determining the leachable nitrogen fraction of the soil. Leachable carbon was determined using analogous methods.

A cellulose filter was inserted into the bottom of an 11.0-mL extraction cell. The cell was then filled with 20-30 mesh cleaned Ottawa sand up to half of the cell's volume. Another cellulose filter was added on top of the sand and then approximately 1.0 g of soil (weighed) was added on top of the filter. A third filter was placed on top of the soil, and the remainder of the cell was filled with Ottawa sand. These precautions prevented channeling in the sample and plugging. The caps of the cell were then tightened, and the cell was loaded onto the instrument. Once the cells were in place

on the instrument, each cell was run under the following ASE extraction method. The cell was filled with water and then heated for five minutes until reaching 60°C. The cell was then pressurized at 800 psi and held at that pressure and temperature for ten minutes. After the static cycle the cell was depressurized and purged for 60 seconds with nitrogen gas. The eluted water was collected in a glass vial and eventually discarded. After the extraction process was completed, each cell was removed from the ASE and disassembled. Most of the moist soil was removed from the cell, leaving some to avoid cross contamination, and placed in an individually labeled glass jar.

The soil was left under a vent hood for three days to dry before being homogenized by stirring and then analyzed on the Costech Elemental Analyzer for total residual nitrogen (TRN). Once both the TN and the TRN had been calculated for each sample, the change between the two was calculated to give the total leachable soil nitrogen (TLSN) for that sample. Analogous procedures resulted in total carbon (TC), total residual carbon (TRC), and total leachable soil carbon (TSON) mass fraction for each sample.

Elemental analysis of carbon and nitrogen

A Costech 4010 ECS Elemental Analyzer (EA; Valencia, CA) was used to quantify carbon and nitrogen in soil samples. Soil samples were ground using a mortar and pestle, dried over calcium carbonate at room temperature until constant weight, thoroughly mixed with a spatula, and weighed (typically 10 mg) into tin boats. Samples were dropped into an oxygen feed furnace and combusted at 1020 °C. Helium carrier gas (100 mL/min) was used to flush combustion gases through reduction and oxidation catalysts to complete conversions to CO_2 and N_2 and to separate these species on a 4-ft gas chromatographic column (70°C). After the gases passed through a ConFlo Interface, the isotope ratio mass spectrometer (described below) served as the detector. Curves of the concentrations of total carbon and nitrogen responses were generated using known amounts of the analytical standard acetanilide and were shown to be linear over the relevant concentration ranges.

Isotopic analysis

Stable isotopic ratios of carbon (C^{13}/C^{12}) and nitrogen (N^{15}/N^{14}) of the effluent gasses from the Costech EA were determined using a Delta S Plus

stable isotope ratio mass spectrometer and Isodat Continuous Flow data acquisition and analysis software (Thermo Finnigan, Waltham, MA) using parameters suggested by the manufacturer. Chromatographic peaks of interest from the Costech EA (CO_2 and N_2) were bracketed using pulses of high-purity CO_2 and N_2 standards, which were introduced into the analytical stream from gas bottles. In each sequence at least one NIST reference material was run, and the reference gases were corrected to the reference materials. The elemental quantities were regressed to the several elemental standards in each sequence, principally acetanilide along with the reference materials.

For nitrogen, average atmospheric nitrogen defines the origin $\delta^{15}N$ (air) = 0.0. The scale was set by NIST RM 8550 (USGS 25) at $\delta^{15}N = -30.4$ and RM 8551 (USGS 26) at $\delta^{15}N = +53.5$. For carbon, Vienna Pee Dee Belemnite defines the origin $\delta^{13}C = 0.00$. In practice NIST RM 8544 (NBS 19) at $\delta^{13}C$ (VPDB) = +1.95 defines VPDB. The scale was set by RM 8542 (IAEA CH6) at $\delta^{13}C = -10.5$ and RM 8539 (NBS 22) at –29.7 and checked by RM 8543 (NBS 18) at –5.0.

The elemental analysis, quantitated by MS and checked by a thermal conductivity detector, has an absolute precision of 0.1%, linearity $r^2 > 0.999$, and standard replicate reproducibility of 0.01%. The isotope procedure typically produced an analytical accuracy for δ in units of parts per thousand difference (per mil, ‰) of 0.2‰ for $\delta^{13}C$ and 0.5‰ for $\delta^{15}N$. The following formula represents the calculation used to determine the stable isotope ratio δ for nitrogen (a similar formula applies to carbon *mutatis mutandis*):

$$\delta^{15}\mathrm{N}‰ \; vs. \; [\mathrm{std}] = \left(\frac{R_{sample} - R_{std}}{R_{std}} \right) \left(1000 \, \delta‰ \right)$$

where

$$R = \left(\frac{At\%^{15}\mathrm{N}}{At\%^{14}\mathrm{N}} \right)$$

Isotopic ratios of total carbon and total nitrogen were directly determined on bulk soil samples. Those of organic carbon and organic nitrogen were determined on bulk soil samples after the treatment at 375°C (loss on

ignition, described above) and back-calculation from isotope mass balance as described below in numerical procedures. The carbon and nitrogen isotopic ratios of leachable carbon were back-calculated from the analysis of bulk soil samples after leaching with water as described below.

Soil lipid analysis

Lipids were extracted from Owens Valley soils using a modified Bligh-Dyer (Bligh and Dyer 1959) extraction procedure (Pinkart et al. 2002). All glassware was rinsed with acetone and treated in a muffle furnace at 450°C for no less than four hours. A 2.0-g (dry weight) soil sample was placed into a mixture of dichloromethane: methanol: water (1:2:0.8, v:v:v) and then in an ultrasonic water bath at 10°C for two minutes. Samples were allowed to stand an additional four hours at room temperature before the liquid phases were separated by the addition of equal volumes of dichloromethane and distilled water. Samples were centrifuged for 15 minutes at 2000 rpm, and the dichloromethane phase was removed with a pipette and placed in a clean test tube. The dichloromethane phase, containing all the total extractable lipids, was dried under a nitrogen stream at no more than 37°C. The remaining soil was air dried for a dry weight.

The total lipid extract was separated into three polarity classes using column chromatography. The dry total lipid was suspended in a minimal volume of dichloromethane and loaded onto an aminopropyl solid phase extraction (SPE) cartridge (Agilent, ACCUBOND II Amino Cartridge, #188-1050). Nonpolar lipids (e.g., sterols) were eluted with 5 mL of dichloromethane. Glycolipids were eluted with 5 mL of acetone. Polar lipids (e.g., membrane phospholipids) were eluted with 5 mL of methanol.

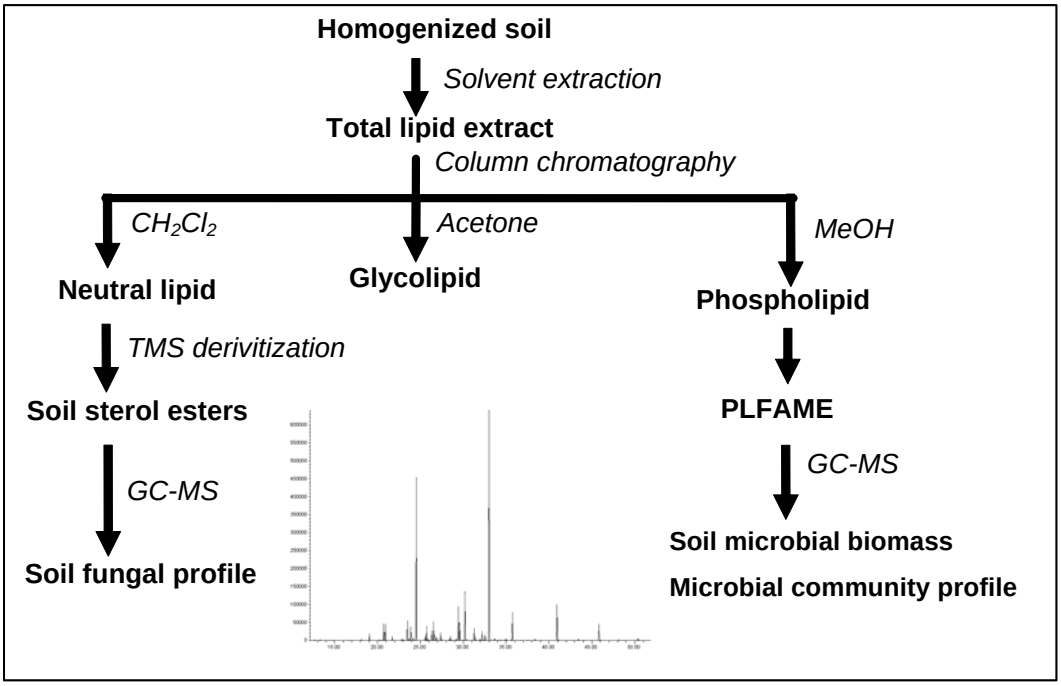

Figure 6. Lipid analytical flow diagram.

Polar lipid fatty acid methyl ester (PLFAME) analysis

The 5 mL of polar lipid eluate from the SPE cartridge was taken to dryness under nitrogen at no more than 37°C (Pinkart et al. 2002). One milliliter of 0.2-M KOH was added to the dried polar lipids in a 15-mL Teflon-lined screw-cap test tube that was tightly sealed and refluxed at 100°C for one hour. After cooling, the pH of the mixture was neutralized with acid and the resulting fatty acid methyl esters were extracted into dichloromethane. The solvent was exchanged to hexane for gas chromatographic analysis.

PLFAMEs were analyzed using a gas chromatograph equipped with a 60-m × 0.25-mm (i.d.) DB-5MS capillary column (0.1 µm film thickness, J&W Scientific, Folsom, CA) and a gas chromatograph paired with a mass selective detector (Hewlett Packard GC6890-5973). Peak identities were confirmed by comparing retention times and mass spectra (with electron impact ionization at 70 eV) to standards and the NIST database. The areas under the peaks were converted to concentrations based on a comparison to an internal standard (methyl nonadecanoate; C19:0). Mass fragmentation was used to confirm the identities of the fatty acid methyl esters. The areas under all PLFAME peaks in a GC trace were summed to provide a measure of the total soil microbial community biomass, and these data were normalized to the gram weight extracted.

For determining PLFAME microbial community profiles, the raw chromatographic data were exported to Excel, and retention times were adjusted and rounded to the nearest 0.05 minutes. This binning procedure provided for the alignment of corresponding peaks within all samples for the purpose of inter-comparison. Once all similar peaks were binned, a principal components analysis (PCA) and other analyses were performed.

Sterol analysis

The nonpolar lipid eluate from the SPE cartridge was dried under a stream of nitrogen and treated with 100 µL of N-methyl-N-trimethylsilyl-trifluoroacetamide (MSTFA; Pierce Chemical, Woburn, MA) mixed in 400-µL dichloromethane. The treatment with mixing in tightly capped tubes continued at 60°C for one hour as per the manufacturer's derivitization protocol. The samples were brought to dryness under nitrogen while cooling to room temperature, then brought up to 0.5 mL in hexane. Cholestane was added after derivatization as an internal standard. GC-MS analyses were performed as described above.

Numerical Analysis and Statistics

Following data collection, a number of numerical procedures including multivariate statistical analysis were used for evaluating the relationships among the data.

Elementary analyses

The majority of numerical procedures were implemented in Microsoft Excel including elementary analysis of variance between pairs of samples.

Normalization

The normalizations used are based on mass balance, which merely assumes conservation of mass. In general for a two-component mixture, one part A and another part B, the ordinary mass balance is expressed as

$$M = M_A + M_B$$

which suffices for mass balance manipulations involving additive quantities including the elemental analyses and lipid analyses. For nonadditive quantities such as isotope ratios, a different procedure must be used and different assumptions must be checked.

The isotope mass balance approximation is

$$\delta \approx \delta_A \frac{M_A}{M_A + M_B} + \delta_B \frac{M_B}{M_A + M_B}$$

where the dimensionless δ is in units of parts per thousand difference (per mil, ‰). To check the isotope mass balance, first the following definitions are introduced in the context of carbon isotopes:

$$M \equiv {}^{12}C + {}^{13}C, \quad R \equiv \frac{{}^{13}C}{{}^{12}C}, \quad \delta \equiv \frac{R - R_s}{R_s} \times 1000$$

Similar definitions are made for nitrogen isotopes. Note the following relations, which follow from the definitions:

$$M = {}^{12}C \times (1 + R) \quad \text{so} \quad {}^{12}C = M \times (1 + R)^{-1},$$
$$^{13}C = {}^{12}C \times R \quad \text{so} \quad {}^{13}C = R \times M \times (1 + R)^{-1},$$
$$\text{and} \quad R = R_s \left(1 + \frac{\delta}{1000}\right)$$

The derivation of the approximation assumes $\delta << 1000$ starting on the third line following:

$$R = \frac{{}^{13}C_A + {}^{13}C_B}{{}^{12}C_A + {}^{12}C_B} = \frac{R_A \times M_A \times (1+R_A)^{-1} + R_B \times M_B \times (1+R_B)^{-1}}{M_A \times (1+R_A)^{-1} + M_B \times (1+R_B)^{-1}} = \frac{R_A \times M_A \times (1+R_B) + R_B \times M_B \times (1+R_A)}{M_A \times (1+R_B) + M_B \times (1+R_A)}$$

$$R = \frac{R_A \times M_A}{M_A + M_B} \frac{(1+R_B)}{1 + \frac{R_B M_A + R_A M_B}{M_A + M_B}} + \frac{R_B \times M_B}{M_A + M_B} \frac{(1+R_A)}{1 + \frac{R_B M_A + R_A M_B}{M_A + M_B}}$$

$$R = \frac{R_A \times M_A}{M_A + M_B}\left(1 + R_B - \frac{R_B M_A + R_A M_B}{M_A + M_B} + O\left(R^2\right)\right) + \frac{R_B \times M_B}{M_A + M_B}\left(1 + R_A - \frac{R_B M_A + R_A M_B}{M_A + M_B} + O\left(R^2\right)\right)$$

$$R = \frac{R_A \times M_A}{M_A + M_B} + \frac{R_B \times M_B}{M_A + M_B} - \frac{(R_A - R_B)^2 \times M_A M_B}{(M_A + M_B)^2} + O\left(R^3\right)$$

$$\therefore \delta = \delta_A \frac{M_A}{M_A + M_B} + \delta_B \frac{M_B}{M_A + M_B} - \frac{R_S \times (\delta_A - \delta_B)^2 \times M_A M_B}{1000 \times (M_A + M_B)^2} + O\left(\left(\frac{\delta}{1000}\right)^3\right)$$

To use the isotope mass balance approximation, it must be checked that the third term of the final line is much smaller than the sum of the first and second terms. Natural abundance carbon and nitrogen isotopes obey this relation, and all the isotope data in this report are of natural abundance and obey this relation.

Multi-sample comparisons

Care must be taken in interpreting statistics such as p-values, when there are many comparisons to be considered together. For a simple example, suppose the null hypothesis were actually true for each of the paired means of samples of the ten locations. At the $\alpha = 0.05$ level, we can say that there is a 95% probability of not finding that $p < 0.05$ for each location. For the ten locations, there is then the probability of only $(0.95)^{10} =$ 60% that none of the ten individual p-values are less than 0.05. Thus there is the rather large 40% probability that at least one of the individual p-values gives the wrong interpretation, for just ten pairs.

But in the more useful example of comparing all the possible pairs of samples means across all ten locations, there are not just ten but $20 \times 19/2 =$ 190 different such pairs, and it becomes exceedingly likely that at least one (in fact, typically 9 or 10 of the 190) of the naively independently calculated p-values will give the wrong interpretation. To give proper interpretations when there are many pair-wise comparisons of means to be considered together, the more stringently calculated Tukey's test of honestly significant differences should be used. The null hypothesis for Tukey's test is again that any observed differences between means are due to random chance.

The proper calculations for Tukey's test take into account all the measurements, but simplified expressions are available when the measurements have the same number of observations for each sample mean. When there are different numbers of observations, as is the case for our measurements, these simplified expressions as implemented in many statistic packages are no longer correct. Different expressions are available when there are large numbers (generally, greater than 30) numbers of observations for each sample mean. But when there are many differing small

numbers of observations, the proper calculations can be difficult to implement. We used a shareware package for Excel by the Instituto Nacional de Enfermedades Respiratorias de México, inerSTAT (http://www.winsite.com/info/pc/win95/excel/inerst13.zip), that reports the results of Tukey's test for up to 20 differing numbers of observations of sample means, which is exactly what we needed.

For each pair of sample means, the reported p-value for Tukey's test is in the context of other pairs of means. The relationship "not significantly different" (nsd) for two sample means is a partial equivalence relation, lacking transitivity, because even if a third sample mean is nsd from one of the two, it may fail to be nsd from the other. "Significantly different" will be denoted sd. Since a partial equivalence relation does not induce a unique partition into equivalence classes, a classification based on multiple pairwise comparisons with Tukey's test may have overlapping classes. Statistical packages that output a classification should emphasize that the classification is not unique, not necessarily just up to trivial class name permutations.

Although it may not be unique, perhaps the best classification is the one with the most classes with the least overlaps. In the context of graph theory and network theory, any such classification is a vertex covering, and the problem of optimizing a vertex covering is known to be nonpolynomial time (NP)-complete. Thus this statistical classifying problem is NP-complete, and such optimization cannot be implemented directly in a finite algorithm guaranteed to produce the correct result. To map the nsd classifying problem to the vertex covering problem, the nsd binary similarity matrix consisting of 1s when pairs are nsd and 0s when pairs are significantly different ($p < 0.05$) is interpreted as the adjacency matrix of an undirected graph. The inclusion of self-similarity appears as singlet self-loops in an otherwise simple reflexive graph, so the self-loops can be ignored.

One heuristic scheme for nsd classifying is the following implementation of a so-called greedy algorithm often used for the vertex covering problem. First choose the sample mean that has the least number of nsd relationships; this mean could be in a class by itself. The set of all of the means that are nsd from the first sample mean comprise the first class, of which the first chosen mean is representative. Of the remaining means (those that are sd from the first chosen mean), the mean that has the least

number of nsd values is chosen to represent the second class. The set of all of the sample means that are nsd from this second representative comprise the second class, which may overlap the first class. The set of means (if any) that are in both the first class and the second class comprise the overlap of the first and second classes, but it is incorrect to distinguish those of a class that are in an overlap from those in that class that are not in the overlap. Of the remaining sample means (those that are sd from the first representative and sd from the second representative), the mean that has the least number of nsd values is chosen to represent the third class. And so on, until there are no remaining sample means.

Although possibly suboptimal, this heuristic greedy algorithm is appropriate for at least bounding the NP-complete classification optimization: the optimum number of classes will be at least that identified by the greedy algorithm, and the optimum number of overlaps will be at most that identified by the greedy algorithm. In the case that the same least number of nsd values is shared by more than one sample mean (as a graph, if more than one vertex has the same minimum degree), then any of those means could be chosen. We conjecture that up to cyclic vertex permutations it should not matter which of those sample means is chosen.

The conjecture is easily checked for sparse adjacency matrices of small graphs, although with overlapping classes the interpretation of the results of vertex permutation needs care. Note that vertex permutation is in general not the same as class name permutation. For larger graphs and less-sparse similarity matrices, especially with realistically overlapping classes, the conjecture is not easy to check, much less prove. Indeed the proofs and procedures of classification theory do not seem to provide any help in dealing with overlaps.

The heuristic greedy algorithm for sample classification is next presented in pseudocode suitable for matrix languages. The input is the binary similarity matrix binsim, a square matrix whose dimension is the number of samples. The output is classim, a vector of alphabet letter class names starting with “a,” then “b,” etc. An overlap is indicated by multiple letters e.g. “ab.”

```
% definitions and initial values
sumsim=sum(binsim);
```

```
% sumsim contains the number of samples to which each sample is similar
% note that the number of samples is the maximum any element of sumsim
can be here

unclassed=ones(1,length(sumsim));
% unclassed is a simple mask to facilitate classification

classim=cell(length(sumsim),1);
for j=1:length(sumsim), classim(j,1)={''}; end
% classim will contain the classes for each sample

classint=0;
% classint is the class name counter

% working loop
while(min(sumsim)<=length(sumsim))
        classint=classint+1;
        sumndx=find(sumsim==min(sumsim));
        binndx=find(binsim(sumndx(1),:)==1);
        for j=1:length(binndx),
                unclassed(binndx(j))=length(sumsim)+1;
                classim(binndx(j))={[char(classim(binndx(j))), char(96+classint)]};
        end
        sumsim=sumsim.*unclassed;
end
```

Multivariate analyses

The correlation of the multivariate data was accomplished using multivariate regression and classification. The different kinds of data representing different kinds of analyses of the samples from various locations were compared, correlated, combined, and regressed to investigate the predictability of characteristics of interest. Multivariate regression is appropriate for describing or predicting properties that are continuous variables. Multivariate classification is appropriate for describing or predicting discrete

variables such as categories or discrete ranges of continuous variables. For instance, the biomass content of the samples can be expected to be correlated with the revegetation class.

A number of multivariate statistical analysis procedures are available for evaluating the relationships among characteristics of samples. Two robust, widely used similarity techniques for classification are k nearest neighbor (KNN) and soft independent modeling of class analogy (SIMCA). KNN categorizes an unknown into a system of predefined classes based on pair-wise (geometric) distances to other members of the database, that is, its k nearest neighbors where k is an integer. A hierarchical cluster analysis (HCA) (usually represented as a dendrogram) is one kind of KNN technique. In contrast to pair-wise comparisons, SIMCA relies on a best-fit similarity to the principal component analysis (PCA) of each individual class of variables. PCA finds the factors or orthogonal linear combinations of descriptive characteristics that maximize variation of the characteristics. Thus the first principal component accounts for the most variation, the second the second most, etc. PCA is fundamental to many multivariate techniques, especially those in which the variation across a data set is most relevant and not simply noise.

A factor-based regression technique that was used is partial least squares (PLS). PLS is related to PCA, except that the factors are not chosen to maximize variation only in the characteristics but also include maximizing correlation with properties of interest. For instance, the PLFAME community analyses may be correlated with the isotopic analyses. Multivariate least-squares regressions usually must implement a kind of mixture analysis and can be very sensitive to outliers. We used the Pirouette software suite (Infometrix, Inc., Bothell, WA) to implement the multivariate analyses.

3 Results and Discussion

Selected physical, chemical, and microbiological characteristics were measured for the 151 surface soil samples from ten locations in the Owens Valley. Our first objective was to determine if surface soils supporting native vegetation differed from those in disturbed areas and, if so, how they differed. Our second objective was to determine if the measured soil characteristics differed between the various land purchase parcels (i.e., varied by location in the Owens Valley) and, if so, how they differed. Our third objective was to identify which soil characteristics co-varied with respect to location in the valley and with native or disturbed status. These goals and the statistical approaches to these goals structure the results section of this report.

We applied selected statistical analyses to the data on the 151 soil samples using a tiered approach. We first used analysis of variance (ANOVA) at a summary level to determine if statistically significant differences (hereafter fixed at the 95% confidence level) existed between soil groupings (locations and native/disturbed) for each soil characteristic determined. We then used multiple ANOVAs and Tukey's test of multiple means to determine where these differences occurred. Hierarchical cluster and principle component analyses were used to group the soils on the basis of the measured soil characteristics and to determine covariance of soil characteristics.

ANOVA Screening of the Soil Characteristics Data

ANOVA was used to analyze data on each soil characteristic, first by pooling data on all 15 soil samples from each of the ten locations (N = 15; number of means = 10) and then by segregating soils from native vegetation from those from disturbed areas (N = 151; number of means = 20). For example, the percentage of silt in the soil varied by an order of magnitude between sample locations named BIS097 and IND131. The results of the ANOVA analysis of the percentage of silt of the ten locations (N and R soils combined) are that these soils differed in their percent silt compositions (P-value < 0.05).

The results of these multiple ANOVAs are summarized in the Appendix A (Tables A99–A104). The P-value is most informative: when P < 0.05, then

there are significant differences at the 0.05 level. We begin each of the following sections of results on groups of soil characteristics with summaries of these ANOVA analyses to survey if significant differences in soils occur with respect to each of these characteristics. The results of additional statistical analysis are then presented and discussed.

Contrasting native and disturbed locations

At each of the ten locations (Figure 1) in the Owens Valley, five of the surface soil samples represented areas of native vegetation (Native), and ten of the surface soil samples represented areas of disturbed sites (Disturbed). The Native vs. Disturbed section of the results is structured to show differences between native and disturbed soils with respect to the measured categories of soils characteristics: soil texture, carbon and nitrogen content, carbon and nitrogen isotopic ratios, polar lipid fatty acid methyl ester, and sterol content. Although many significant differences were demonstrated among the physical, elemental, and isotopic characteristics determined for these 151 soil samples, the strongest and most frequently consistent differences between native and disturbed areas were those related to soil microbiology. In each category of soil characteristic an ANOVA was first performed to determine if statistical differences occurred for this characteristic among the 151 soil samples. Appropriate additional data analyses were then conducted to determine where the differences lie.

Soil texture

Multiple ANOVAs showed some of the 151 Owens Valley surface soil samples differed in their relative percentages of sand, silt, and clay when grouped only by the ten parcel locations and again when each of these locations was further segregated into soils collected from native and disturbed locations (Table 2).

Table 2. Analysis of variance of percent silt values of all the 151 Owens River surface soil samples grouped into ten locations corresponding to land purchase parcels. Since $P < 0.05$, then for silt there are significant differences between locations at the $\alpha = 0.05$ level.

Source of variation	SS	Df	MS	F	P-value	F crit
Between locations	19824.97	9	2202.774	32.5453	2.8E–30	1.946863
Within locations	9543.35	141	67.68333			
Total	29368.32	150				

Table 3. Summary of P-values from multiple ANOVAs derived from Tables A99–A104, showing significant (α = 0.05) differences in silt, sand, and clay compositions of the 150 Owens River surface soil samples grouped only by location of the land parcel (10 groups) or location groups further divided by history of disturbance (20 groups).

Bulk parameter	10 groups R together with N P-value	20 groups R separate from N P-value
Sand	1.13E–31	5.69E–30
Silt	2.80E–30	3.46E–29
Clay	2.52E–17	2.52E–18

Subsequently, multiple pair-wise ANOVAs on the percentages of sand, silt, and clay compositions of the 151 Owens Valley surface soil samples were performed to determine if there were significant differences in soil texture between many native and disturbed sites. The means and standard deviations of the characteristic of the ten samples of disturbed soils at each location were compared to those of the five samples of soils supporting native vegetation at each parcel location (Appendix A, Tables A80–A82). P-values from these pair-wise ANOVAs are used to summarize the results of these analyses (Table 3). Means of the relative abundances of sand, silt, and clay in native soils differed from disturbed soils in five of the ten locations (Table 4). However, the more stringent Tukey's analysis showed far fewer honestly significant differences in these measures of soil texture; at most two of the ten locations had honestly significant differences between N and R soil textures. The gross soil texture would primarily be due to geological factors that would be expected to vary with location in the Owens Valley watershed and would not be heavily influenced by the presence or absence of vegetation in any one location. Differences in soil texture between the ten land parcel locations and their relationships to previous soil classifications will be discussed in the following section of the results.

Table 4. Average soil textures of ten disturbed and five native sites at each of the ten locations in the Owens River valley. Soil texture is expressed as percent sand, slit, and clay. P-values less than 0.05 indicate that the means of the disturbed (R) and native (N) soils are different at the 95% C.I. level using ANOVA. Additional information on these ANOVA analyses summarized in this table is provided in Tables A99–A104. Means followed by the same letter are not significantly (95% C.I.) different using Tukey's test for comparing multiple means.

	Sand				Silt				Clay			
Sample Name	Mean	StDev	P-value	Tukey	Mean	StDev	P-value	Tukey	Mean	StDev	P-value	Tukey
BGP R	79.60	4.97		C	7.80	3.19		C	12.60	2.67		BC
BGP N	83.60	2.97	0.1232	C	7.60	2.19	0.9022	C	8.80	1.79	0.0129	BC
BIS097 R	83.40	6.60		C	5.40	4.62		C	11.20	2.86		BC
BIS097 N	90.00	2.00	0.0495	C	3.20	1.10	0.3199	C	6.80	2.28	0.0099	B
BLK016 R	58.20	8.92		B	33.40	9.48		B	8.40	2.46		B
BLK016 N	56.80	13.31	0.8106	B	28.80	11.37	0.4194	B	14.40	5.55	0.0103	BC
FSL201 R	75.80	8.13		C	9.80	6.21		C	14.40	3.98		C
FSL201 N	73.33	8.45	0.5712	BC	12.00	6.32	0.5061	C	14.67	4.50	0.9031	BC
IND105 R	43.20	11.20		A	32.60	11.51		B	24.20	2.90		A
IND105 N	60.00	7.48	0.0094	B	20.80	5.76	0.0510	B	19.20	2.28	0.0047	AC
IND123 R	64.40	16.97		B	16.20	13.74		C	19.40	5.42		AC
IND123 N	65.20	6.57	0.9216	B	19.20	10.64	0.6768	BC	15.60	5.90	0.2335	C
IND131 R	37.20	11.00		AB	46.80	7.73		A	16.00	4.90		C
IND131 N	52.80	14.39	0.0343	AB	28.80	13.61	0.0051	B	18.40	6.23	0.4260	AC
LAW082 R	76.80	5.01		C	8.80	3.16		C	14.40	2.95		C
LAW082 N	82.40	2.61	0.0361	C	7.20	1.10	0.2967	C	10.40	1.67	0.0147	BC
LAW090 R	76.60	2.99		C	11.80	2.57		C	11.60	1.58		BC
LAW090 N	82.80	3.35	0.0026	C	7.20	2.28	0.0045	C	10.00	1.41	0.0768	BC
LAW118 R	69.40	10.20		B	15.60	7.04		C	15.00	4.03		C
LAW118 N	66.40	6.07	0.5581	B	21.60	6.99	0.1412	B	12.00	1.41	0.1338	BC
Number of sites with R & N differences			5	1			2	2			5	0

Carbon and nitrogen elemental content

The 151 Owens Valley surface soil samples were characterized by their mass of carbon and nitrogen in the total soil, loss upon treatment in a muffle furnace, and loss by leaching with distilled water. Loss on ignition refers to the loss to the total mass of soil lost upon treatment in a muffle furnace. A summary ANOVA showed that some of the 151 Owens Valley soils significantly differed in these bulk soil characteristics (Table 5). These differences were significant when values for native and disturbed soils were grouped together (i.e., ten locations) and when these values for native and disturbed soils were treated as separate groups for each location (i.e., 20 groups). Only the values in bold—leachable carbon and leachable nitrogen—were not different. P-values show there are significant differences between some of the ten locations at the $\alpha = 0.05$ level for the elemental carbon and nitrogen analyses. Separating the R and N did not change that conclusion for most of these bulk parameters. These significant differences make it reasonable to explore the meaning of the differences in more detail.

Table 5. Summary of P-values from multiple ANOVAs derived from Tables A99–A104, showing significant (α = 0.05) differences in bulk soil and carbon and nitrogen compositions of the 150 Owens River surface soil samples grouped only by location of the land parcel (10 groups) or grouped by location and history of disturbance (20 groups).

Bulk parameter	10 groups R together with N P-value	20 groups R separate from N P-value
Loss on ignition	1.13E–31	5.69E–30
Total carbon	2.80E–30	3.46E–29
Total nitrogen	2.52E–17	2.52E–18
Leachable carbon	2.74E–01	8.71E–03
Leachable nitrogen	6.37E–02	5.48E–08
Organic carbon	2.03E–08	7.02E–17
Organic nitrogen	2.10E–18	3.09E–25

Pair-wise ANOVA comparisons of the elemental compositions of native and disturbed soils from the 10 Owens Valley locations reveal where some of these differences may lie (Table 6). Total carbon, total nitrogen, organic carbon, and organic nitrogen P-values from individual comparisons of native and disturbed soils were less than 0.05 for the majority of the 10 sample locations. The mean total carbon levels were higher in the native soils than in the disturbed soils in seven of the eight locations shown by pair-wise ANOVA to be significantly different. The Tukey's analysis again showed fewer differences at the 95% confidence level. Tukey's test of multiple means showed that only those soils from the IND123 location exhibited significant differences between native and disturbed sites for all the fractions of carbon and nitrogen elements measured.

Table 6. Average soil carbon and nitrogen contents of ten disturbed and five native sites at each of the ten locations in Owens Valley. Total and organic fractions of each element are shown. P-values less than 0.05 indicate that the means of the disturbed and native soils are different at the 95% C.I. level using ANOVA. Additional information on these ANOVA analyses summarized in this table is provided in Tables A99–A104. Means followed by the same letter are not significantly (95% C.I.) different using Tukey's test for comparing multiple means.

Sample Name	Total Carbon (µg/g)				Total Nitrogen (µg/g)				Total Organic Carbon (µg/g)				Total Organic Nitrogen (µ		
	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat
BGP R	24.84	9.81		C	2.46	0.88		B	22.66	9.47		BC	1.96	0.85	
BGP N	16.19	6.24	0.0968	C	1.53	0.50	0.0485	C	13.32	5.32	0.0622	BC	0.97	0.40	0.0277
BIS097 R	10.33	3.66		C	1.31	0.50		C	9.65	3.35		C	1.08	0.42	
BIS097 N	8.02	2.26	0.2228	C	0.95	0.24	0.1469	C	7.18	2.10	0.1585	BC	0.78	0.21	0.1516
BLK016 R	62.51	7.55		AB	2.06	0.47		C	14.87	6.89		BC	1.62	0.41	
BLK016 N	73.48	9.75	0.0300	AB	4.99	1.35	0.0000	AB	47.40	17.53	0.0001	AB	4.08	1.27	0.0001
FSL201 R	14.13	4.94		C	1.19	0.36		C	10.33	4.01		C	0.80	0.29	
FSL201 N	28.14	9.06	0.0011	C	2.19	0.56	0.0005	BC	20.25	9.25	0.0089	BC	1.50	0.58	0.0055
IND105 R	59.36	11.93		A	2.74	0.53		B	25.00	7.92		B	2.07	0.45	
IND105 N	73.80	7.37	0.0277	AB	3.28	0.46	0.0689	B	26.92	4.61	0.6274	BC	2.45	0.35	0.1179
IND123 R	29.48	16.30		C	1.84	0.93		C	17.47	11.66		BC	1.42	0.81	
IND123 N	91.41	56.48	0.0051	B	6.34	4.09	0.0041	A	60.99	48.85	0.0153	A	5.18	3.12	0.0024
IND131 R	62.21	25.96		AB	3.81	1.06		B	30.69	11.90		B	2.88	0.83	
IND131 N	91.45	18.74	0.0429	C	5.32	2.36	0.1029	AB	47.37	26.08	0.1043	AB	3.86	1.60	0.1344
LAW082 R	8.27	2.79		C	0.63	0.32		C	3.17	3.05		C	0.41	0.29	
LAW082 N	26.80	17.62	0.0046	C	1.75	1.13	0.0089	BC	22.38	16.97	0.0029	BC	1.50	1.10	0.0091
LAW090 R	23.99	5.10		C	1.10	0.35		C	11.12	5.24		BC	0.70	0.29	
LAW090 N	15.58	2.25	0.0038	C	0.55	0.21	0.0074	C	2.73	2.73	0.0051	C	0.32	0.21	0.0192
LAW118 R	15.24	2.37		C	0.74	0.15		C	5.43	2.08		C	0.40	0.14	
LAW118 N	25.82	4.31	0.0000	C	1.70	0.32	0.0000	C	13.38	3.36	0.0001	BC	0.97	0.33	0.0003
Number of sites with R & N differen			8	2			7	3			6	1			7

The mean total nitrogen content of water-leachable carbon and nitrogen showed fewer differences, with P-values less than 0.05 (Appendix A, Table A98).

Carbon and nitrogen isotopic ratios

A summary ANOVA of the carbon and nitrogen isotopic data also showed differences between native and disturbed soils (Table7). "Organic" and "leachable" are described in the previous section and functionally defined in the methods section. Values that were not significantly different are shown in bold font. For the isotopic data as seen in Tables A52–A61 in Appendix A, much of the largest variation in the leachable and organic values is due to very low elemental masses spuriously amplifying the isotopic ratio, resulting from dividing by a small number. For example the spurious value of +27.351 reported for leachable $\delta^{13}C$ for BIS097 N-4 is due to the small value of 0.202 mg/g for leachable carbon. Note that most of these spurious values would not be replaced by much better values solely by using much more material (e.g. 20 mg instead of 2 mg) since the small numbers result from subtracting two large numbers.

Table 7. Summary of P-values from multiple ANOVAs derived from Tables A99–A104 showing significant (α = 0.05) differences in carbon and nitrogen isotopic ratios of the 150 Owens River surface soil samples grouped only by location (10 groups) of the land parcel or grouped by location and history of disturbance (20 groups).

Bulk parameter	10 groups R together with N P-value	20 groups R separate from N P-value
Total $\delta^{13}C$	1.75E–26	2.44E–36
Total $\delta^{15}N$	6.57E–11	7.02E–19
Leachable $\delta^{13}C$	5.11E–03	**3.46E–01**
Leachable $\delta^{15}N$	**4.79E–01**	**7.96E–01**
Organic $\delta^{13}C$	**9.35E–01**	**1.78E–01**
Organic $\delta^{15}N$	8.68E–08	5.36E–09

Pair-wise ANOVA analysis of the carbon and nitrogen isotopic analysis showed that some soils from native and disturbed areas of the ten parcel locations differed (Table R8).

Table 8. Average carbon and nitrogen isotopic ratios of ten disturbed and five native sites at each of the ten locations in the Owens Valley. Total and organic fractions of each element are shown. P-values less than 0.05 indicate that the means of the disturbed and native soils are different at the 95% C.I. level using a pair-wise ANOVA. Additional information on these ANOVA analyses summarized in this table is provided in Appendix A (Tables A99–A104). Means followed by the same letter are not significantly (95% C.I.) different using Tukey's test for comparing multiple means. Tukey's showed no significant difference in the leachable fraction.

Sample Name	Total d13C				Total d15N				Organic d13C				Organic d15N			
	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey
BGP R	-22.88	0.82		B	7.20	0.93		C	-23.33	0.92		A	7.22	1.17		B
BGP N	-23.66	0.72	0.0947	B	5.90	1.23	0.0362	BC	-24.92	0.56	0.0035	A	4.83	2.51	0.0222	B
BIS097 R	-22.75	0.68		B	5.27	0.85		BC	-22.95	0.72		A	5.43	1.09		B
BIS097 N	-20.08	2.19	0.0028	BC	5.22	1.16	0.9341	BC	-20.31	2.24	0.0035	A	5.56	1.34	0.8380	B
BLK016 R	-7.74	1.55		A	5.30	1.19		BC	-26.06	5.41		A	5.35	1.31		B
BLK016 N	-15.58	4.77	0.0002	C	6.73	1.80	0.0847	C	-22.26	2.04	0.7929	A	6.39	2.15	0.2600	B
FSL201 R	-20.60	1.91		B	5.63	1.49		C	-23.00	1.22		A	6.18	2.06		B
FSL201 N	-18.91	3.21	0.2026	BC	7.40	2.04	0.0636	C	-23.33	3.87	0.8036	A	6.38	2.39	0.8635	B
IND105 R	-14.95	2.70		C	7.18	1.30		C	-26.01	5.99		A	6.96	1.49		B
IND105 N	-10.85	1.47	0.0074	AC	10.08	1.40	0.0014	A	-21.51	0.90	0.1237	A	10.03	1.65	0.0028	B
IND123 R	-15.96	2.14		C	6.57	2.99		C	-22.68	5.79		A	6.73	3.19		B
IND123 N	-17.77	1.79	0.1277	BC	11.18	0.54	0.0048	A	-28.33	16.10	0.3263	A	10.86	0.80	0.0142	B
IND131 R	-17.07	7.43		C	5.73	1.80		C	-22.08	3.48		A	5.90	2.27		B
IND131 N	-13.07	3.66	0.2811	C	9.47	1.16	0.0009	A	-20.25	1.68	0.2888	A	9.14	1.67	0.0137	B
LAW082 R	-9.73	3.01		A	5.03	1.18		B	-22.73	6.98		A	2.86	9.04		A
LAW082 N	-19.84	3.02	0.0000	BC	4.47	2.30	0.5343	BC	-23.48	1.65	0.3264	A	4.77	2.57	0.6561	B
LAW090 R	-8.95	2.12		A	2.89	1.03		B	-19.30	7.26		A	2.99	1.99		A
LAW090 N	-5.33	2.34	0.0092	A	5.19	1.95	0.0086	BC	-35.71	19.51	0.2543	A	6.75	2.49	0.0066	B
LAW118 R	-8.97	1.86		A	4.02	1.50		BC	-24.80	14.79		A	-2.56	6.93		A
LAW118 N	-16.30	1.45	0.0000	C	5.70	1.14	0.0460	BC	-24.86	2.74	0.9934	A	4.43	1.74	0.0466	B
Number of sites with R & N differences			6	3			6	3			2	0			6	3

The $\delta^{15}N$ of the three disturbed IND locations all show significantly heavier ratios, probably indicating ordinary fertilizer with heavier nitrogen via the Haber process. Autotrophs discriminate against heavy carbon (^{13}C) to vari-

ous but characteristic extents. C3 plants generally have their $\delta^{13}C$ range from –20 to –33‰. C4 plants generally range from –5 to –18‰. Crassulacean acid metabolism (CAM) plants overlap these two ranges. The carbon isotopic ratios of soil CO_2 generally tend to reflect the dominant primary producers. The three locations (BLK016, LAW082, and LAW118) that showed total carbon $\delta^{13}C$ significant differences (Tukey's 95% C.I.) had more negative $\delta^{13}C$ values for soils supporting native vegetation (~ –16‰) than soils in disturbed sites (~ –9‰). The organic carbon $\delta^{13}C$ values showed only two P-values smaller than 0.05 and no significant difference by Tukey's. However, the standard deviations of the organic carbon $\delta^{13}C$ measurements were generally higher than those of the total carbon (±0.2‰) because the low total mass of organic carbon in these samples was low. The organic carbon $\delta^{13}C$ values were generally more negative than the total carbon $\delta^{13}C$ values.

Soil lipids

The largest and most frequently shown differences between characteristics of soils from native plant sites and those from disturbed sites were those of lipids used to characterize soil communities (Table 9). The sum of all polar membrane lipid fatty acid methyl esters (PLFAMEs) measured per gram dry weight of soil was used as a measure of soil microbial community biomass. Soils sterols are contributed from eukaryotic organisms, mainly plants (phytosterols) and fungi (ergosterol). Summary ANOVA analyses showed significant differences in surface soil lipids between native and disturbed sites (Table 9). The value in bold was not significantly different.

Table 9. Summary of P-values from multiple ANOVAs derived from Tables A99–A104 showing significant (α = 0.05) differences in carbon and nitrogen isotopic ratios of the 150 Owens Valley surface soil samples grouped only by location (10 groups) of the land parcel or grouped by location and history of disturbance (20 groups).

Bulk parameter	10 groups R together with N P-value	20 groups R separate from N P-value
Total PLFA	**1.09E–01**	3.75E–24
Total sterols	1.86E–02	4.59E–22

Pair-wise ANOVA analyses were used to help identify where the differences in total biomass (PLFAME) and total sterols occurred (Table 10). P-values for these analyses were less than 0.05 for nine of the ten PLFAME

comparisons and for seven of the ten sterol comparisons. These lipids extracted from the native soils tend to be an order of magnitude greater than lipids extracted from the disturbed soils. The soil from the native vegetation was an exception to this generalization. The more stringent Tukey's test for multiple means showed Owens Valley surface soils from seven of the ten parcel locations differ in microbial biomass (total PLFAME) when native soil was compared to disturbed soil, and five of the ten differed in total sterol content. The total soil sterols levels were generally higher in soils supporting native plants than soils from disturbed locations.

Table 10. Average soil total microbial community biomass (total pmole polar lipid fatty acid methyl ester per gram dry weight) and sterol content (total pmole sterols/gdw) content of ten disturbed and five native sites at each of the ten locations in the Owens Valley. P-values less than 0.05 indicate that the means of the disturbed and native soils are different at the 95% C.I. level using a pair-wise ANOVA. Additional information on these ANOVA analyses summarized in this table is provided in Appendix A (Tables A71–72; A89-90). Means followed by the same letter are not significantly (95% C.I.) different using Tukey's test for comparing multiple means.

	PLFAME Biomass (pmole/gdw)				Total Sterols (pmoles/gdw)			
Sample Name	Mean	StDev	P-value	Tukey	Mean	StDev	P-value	Tukey
BGP R	2462.36	1087.87		C	6283.97	2435.82		B
BGP N	6872.27	3518.99	0.0022	B	6068.73	4695.48	0.9069	B
BIS097 R	1383.76	908.46		C	8463.85	3152.52		B
BIS097 N	4085.82	3480.25	0.0321	BC	14483.84	12761.66	0.1675	B
BLK016 R	575.56	591.50		C	3451.08	2490.48		B
BLK016 N	8849.25	6203.16	0.0007	B	36086.22	23927.61	0.0006	A
FSL201 R	763.62	679.55		C	2947.28	2306.53		B
FSL201 N	7677.26	3908.22	0.0001	B	19908.95	13219.97	0.0011	A
IND105 R	490.18	363.29		C	3164.82	1815.66		B
IND105 N	6700.84	2575.44	0.0000	B	12195.36	4060.76	0.0000	B
IND123 R	1579.32	2495.03		C	5654.95	5608.06		B
IND123 N	7091.34	2623.65	0.0014	B	25583.41	13563.77	0.0011	A
IND131 R	1082.60	1377.74		C	3155.45	1721.96		B
IND131 N	16368.98	8828.99	0.0001	A	35368.15	17812.85	0.0000	A
LAW082 R	342.20	201.64		C	361.92	324.89		B
LAW082 N	2488.36	1231.68	0.0001	C	6178.12	4838.73	0.0015	B
LAW090 R	1013.11	328.42		C	1316.64	660.93		B
LAW090 N	1828.44	1623.25	0.1360	C	1480.48	1475.53	0.7661	B
LAW118 R	699.90	484.20		C	1834.97	2413.86		B
LAW118 N	9294.06	5930.34	0.0003	B	21555.61	11836.96	0.0001	A
Number of sites with R & N differences			9	7			7	5

Polar membrane lipid fatty acid methyl ester profiles

In addition to estimates of total soil community microbial biomass provided by the sum of all PLFAMEs in a soil sample, the levels of individual

PLFAME in a soil provides information on the profile of the soil microbial community. Approximately 125 fatty acids (by GC retention times) were detected in the 150 surface soil samples from the Owens River Valley. In this report we interpret PLFAME soil profiles in two ways. The first is to use them as a fingerprint pattern for characterizing each soil and then to compare each group of the soils on the basis of similarity of these PLFAME patterns. This interpretation requires few assumptions and provides a straightforward means to classify the soils with respect to their resident biological communities. These PLFAME data are also interpreted in terms of operationally defined taxonomic units. Pinkart et al. (2002) used terminally branched saturated PLFAME to depict Gram-positive bacteria in soil microbial communities. Analogously, monounsatured PLFAMEs were used to represent Gram-negative bacteria. Mid-chain methyl branched PLFAMEs were used to represent actinomyces. Terminally branched monounsaturated PLFAMEs were used to represent iron- and sulfate-reducing bacteria. Polyunsatuared PLFAMEs were used to represent eukaryotes. Although it is of low resolution relative to methods based on nucleic acid sequence, this approach provides a useful means to survey differences in soil microbial community compositions.

Although these PLFAME fingerprint data are complex, visual recognition of the patterns in the stacked bar graph (Figure 7) provides useful information. In this figure each color and pattern code depicts one of the 125 PLFAMEs (see Appendix B for key). Surface soil samples from native vegetation sites from the IND123 location generally have complex but similar PLFAME patterns. This is a general trend for the majority of the ten Owens Valley locations studied (Appendix B, Figures B1–B10.) IND123 was selected here to show that the consistency of this trend is strong enough to identify samples like IND123 R-8 and IND123 R-9 as being different and warranting additional investigation.

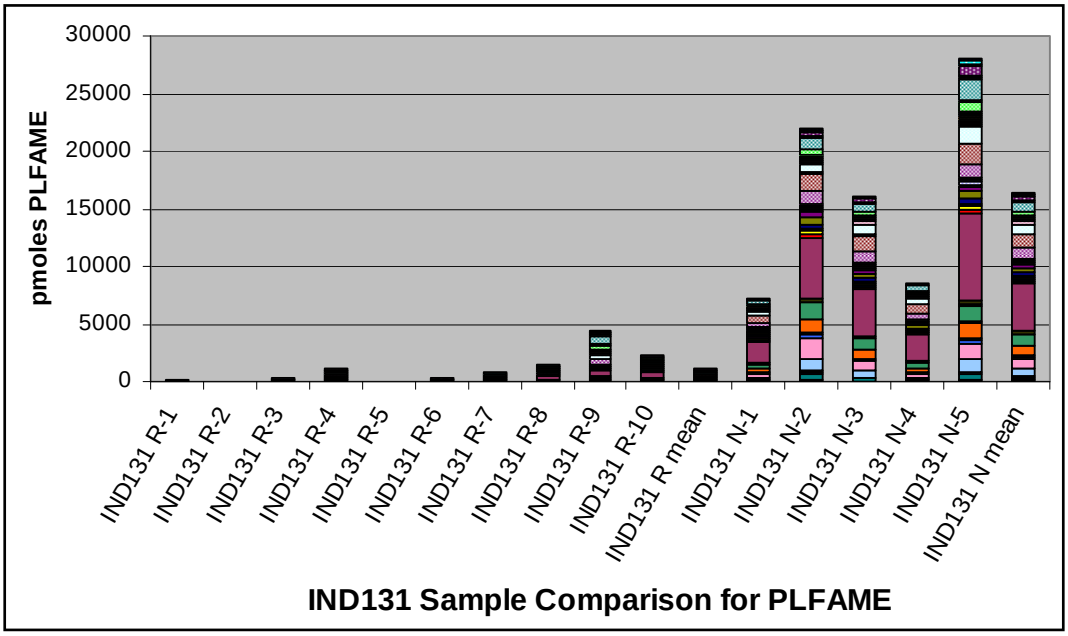

Figure 7. Levels (pmole PLFAME/gram dry weight) of polar lipid fatty acid methyl esters in soil samples from the ten disturbed and five native sites and their respective averages at the IND131 location. The key to the PLFAME code can be found in Appendix B, Figure B1.

Although there was considerable variability in the PLFAMEs of Owens Valley within the five surface soils from each of the native sites and ten disturbed sites at each of the ten land parcel locations, averaging the respective PLFAME profiles provided useful information as to how the soils from native vegetation differed from disturbed soils with respect to their average microbial communities (Figure 8). The native soils with the highest PLFAME biomass tended to be most different from their corresponding disturbed soils (e.g., IND131, LAW118, and BLK106).

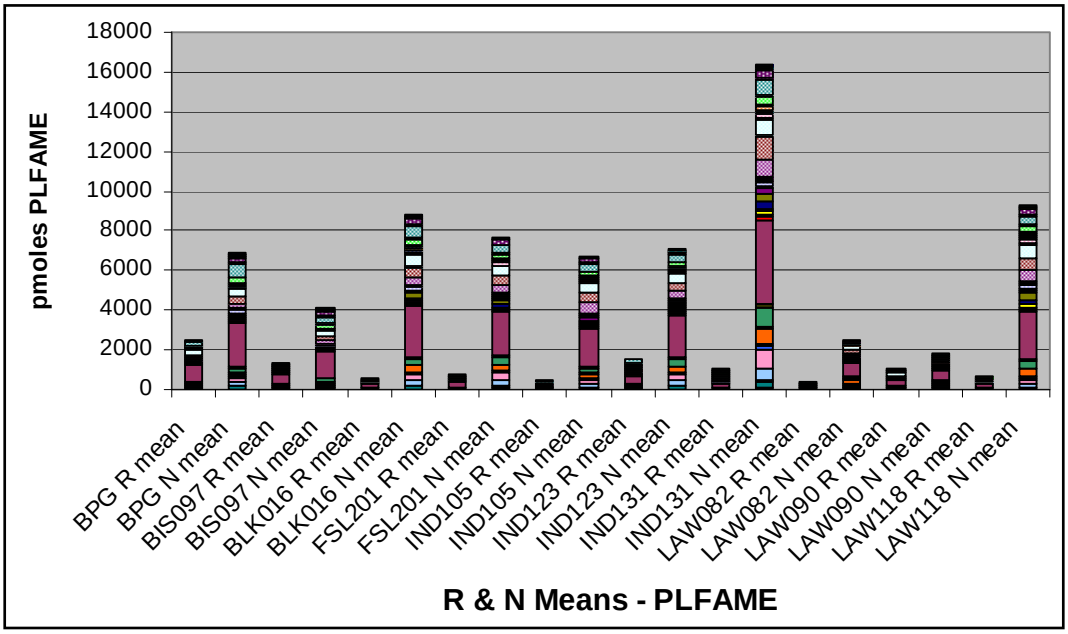

Figure 8. Average levels (pmole PLFAME/gram dry weight) of individual polar lipid fatty acid methyl esters in soils from ten disturbed (R) and five native (N) sites at each of the ten locations. The key to the PLFAME code can be found in Appendix B, Figure B5.

The PLFAME data were also interpreted in terms of operationally defined taxonomic units based on the taxonomic distribution and use of selected fatty acid biosynthetic pathways (outlined above). Comparison of the averages of these PLFAME-defined taxonomic units between disturbed soils (Figure 9) and soils supporting native vegetation (Figure 10), shows large differences in the absolute abundances of these taxa (note the differing scales on the Y-axes) but only a few differences in their relative abundances. As expected, the straight-chained saturated fatty acids that are found in most microbial taxa are the most abundant in all the soil microbial community profiles and provide little information about the microbial community composition. The largest differences are seen in the group labeled "Other PLFAME." Mass spectral analysis of the most abundant PLFAME in this category showed that they were mainly composed of a carbon length series of dioic fatty acids (i.e., a carboxylic acid group on each end of the CH_2 carbon chain), for which we had no standards to compare. These PLFAMEs are highly usual and have been only reported to occur in the environment in some fungi. These PLFAME may be involved in the specialized membranes functions needed to transfer water and nutrients between plant and fungal cells.

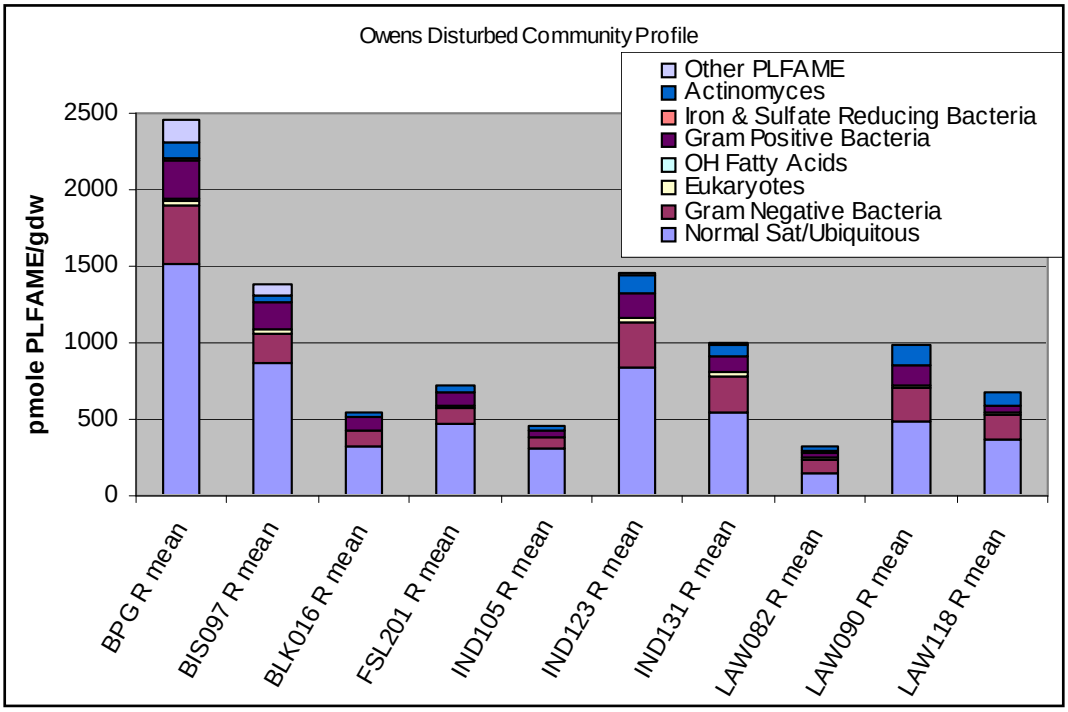

Figure 9. Average levels (pmole PLFAME/gram dry weight) of groups of polar lipid fatty acid methyl esters extracted from ten disturbed (R) soils at the ten land parcel locations that can be interpreted in terms of operationally defined taxonomic units.

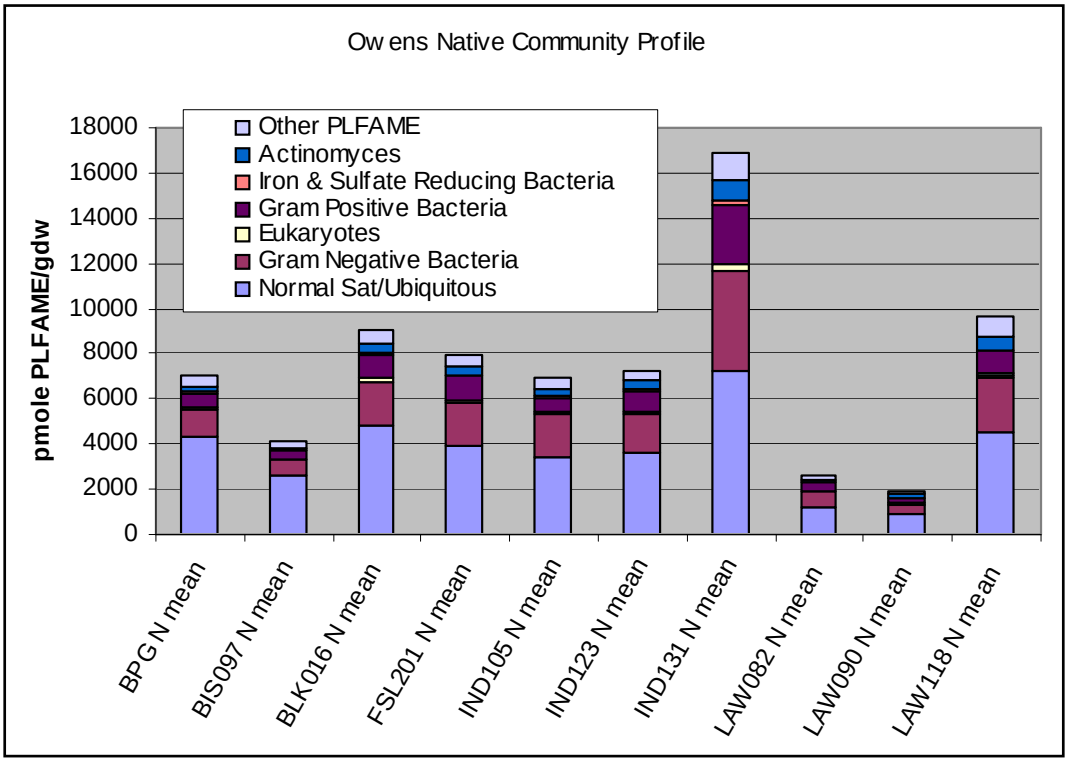

Figure 10. Average levels (pmole PLFAME/gram dry weight) of groups of polar lipid fatty acid methyl esters extracted from five soils supporting native vegetation at the ten land parcel locations that can be interpreted in terms of operationally defined taxonomic units.

Sterol profiles

There are approximately 250 sterols and related compounds in plant and marine materials, with the most common being beta-sitosterol, stigmasterol, and campesterol. Beta-sitosterol is synthesized by plants. Other sterols include ergosterol, a principal sterol in the membranes of fungi that has been used as a biomarker for the presence of fungi in environmental samples (Puglisi et al. 2003), and coprostanol, a product of cholesterol transformation by bacteria in the gut track that is used as an indicator of fecal material. The absolute abundance (pmoles/gram dry weight of soil) of the phytosterols (beta-sitosterol and stigmasterol) and the fungal steroid ergosterol were consistently and significantly higher in soils from the native vegetation areas than in the soils from the disturbed sites of the IND131 location (Figure 11).

The structures of many other sterols await confirmation using authentic standards and are here identified only by retention times. The sterol trend at the IND131 location was generally true at the other nine locations, but the variation of soil samples collected appropriately every 10 m along transects through native and disturbed sites showed considerable variability and the extent of variability varied from location to location (Appendix B, Figures B14–B24). Even with this variability among soil samples from native and disturbed transects, the mean individual sterol levels for native and disturbed soils were generally very different from one another (Figure 12). Locations showing the largest differences between native and disturbed sites also showed large difference in levels of plant and fungal sterols.

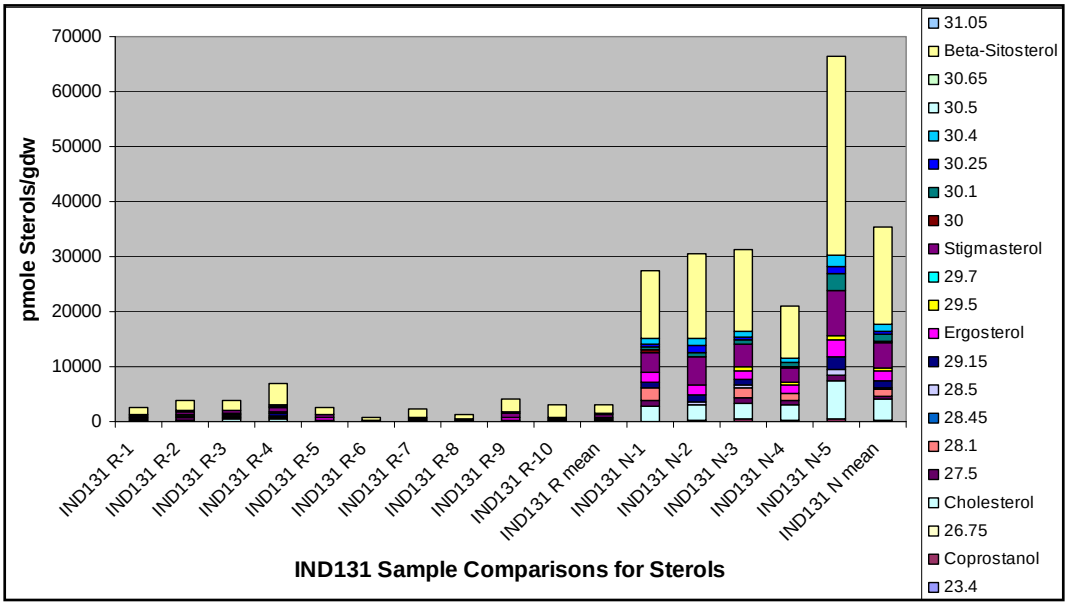

Figure 11. Levels (pmole sterol/gram dry weight) of sterols in soil samples from the ten disturbed and five native sites and their respective averages at the IND131 location.

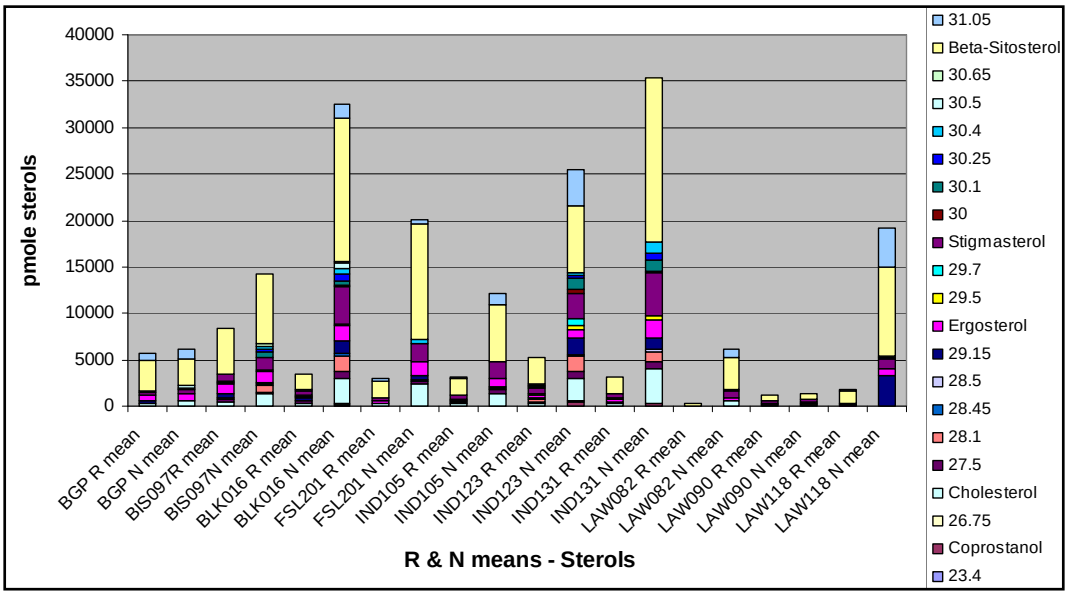

Figure 12. Average levels (pmole sterol/gram dry weight) of individual sterols in soils from ten disturbed and five native sites at each of the ten locations.

Additional interpretation of the soil sterol data in the context of the bio-synthetic origins of the sterols will be conducted after the structure of the sterols has been identified by comparison of retention times and mass spectra with authentic standards.

Combined PLFAME and sterol profile data

There are 171 individual lipids in the Owens River lipid profiles. Up to half of the 128 PLFAMEs in these samples are identified by external standards and/or MS libraries, but only a half dozen of the 43 sterols in these samples have been unambiguously identified. Some lipids, 20 or so of the 128 PLFAMEs and 20 or so of the 43 sterols, only occur in a few samples. A large number of the rarer PLFAMEs are at low levels in the samples, while many of the rarer sterols are at high levels.

Since the Owens Valley surface soil samples from sites supporting native vegetation strongly differed in lipid composition from soil from disturbed sites, we used multivariate analyses to explore the type and extent of these differences. Kennedy et al. (2005) used similar analyses to determine the impacts of plant species and the additions of lime and ammonia on soil fungal community structure. Hierarchical cluster analysis (HCA) and principal component analysis (PCA) were applied to the combined PLFAME and sterol profiles, and subsequently to the grand data set of these lipid profiles together with the other measured characteristics: soil texture, carbon and nitrogen contents, and stable isotopic ratios.

Figure 13 shows the HCA of combined PLFAME and sterol profiles. The disturbed samples form a largely undifferentiated group separated from one cluster of some of the native samples, but many of the native samples group with the disturbed samples. The PCA of the combined lipids (Figure 14) reveals more information. The disturbed samples mostly bunch together, but many of the disturbed samples show much wider variability than the disturbed samples.

The grand HCA (Figure 15) exhibits much more clustering than the HCA of the lipids alone. The disturbed samples especially show much more structure in the dendrogram, with several clusters of disturbed samples. Including more data besides lipids improves the ability of multivariate techniques to discriminate samples, e.g. within the disturbed group, but for these data the differentiation between native and disturbed samples is improved with neither the HCA nor the PCA (Figure 16). The lipids continue to provide the only real discrimination.

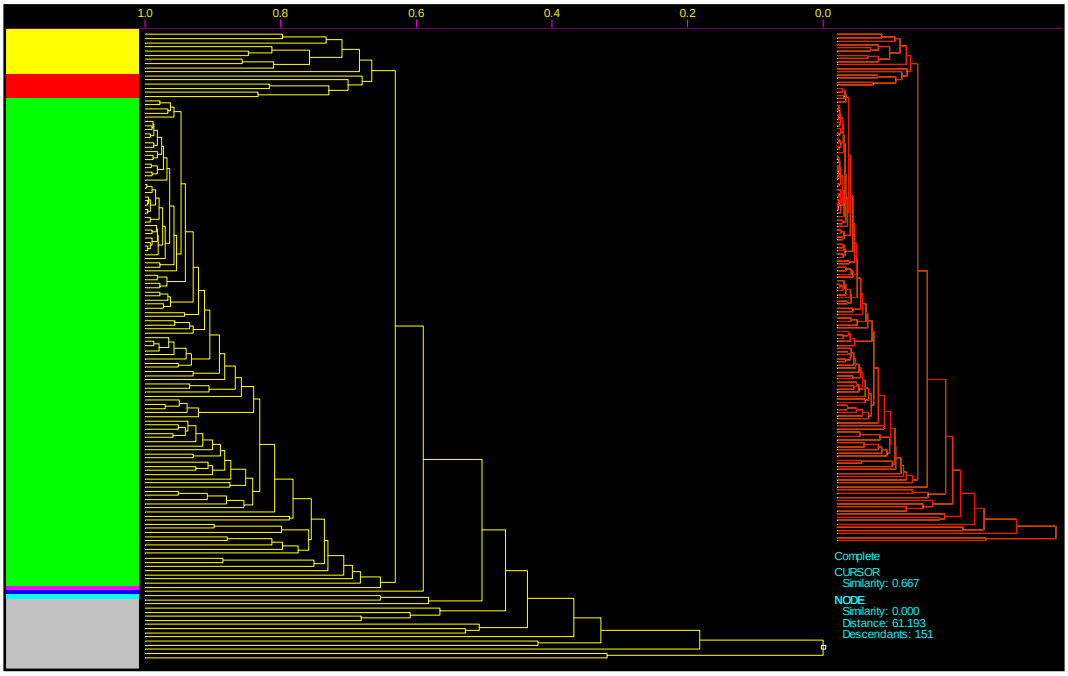

Figure 13. HCA of combined PLFAME and sterol profiles. This dendrogram shows a largely undifferentiated group (green) in the middle, which is composed almost entirely of disturbed (R) samples, a different cluster (yellow, red) at the top, which is composed entirely of native (N) samples, and a significant number of more variable samples (gray) at the bottom, which are mostly native samples.

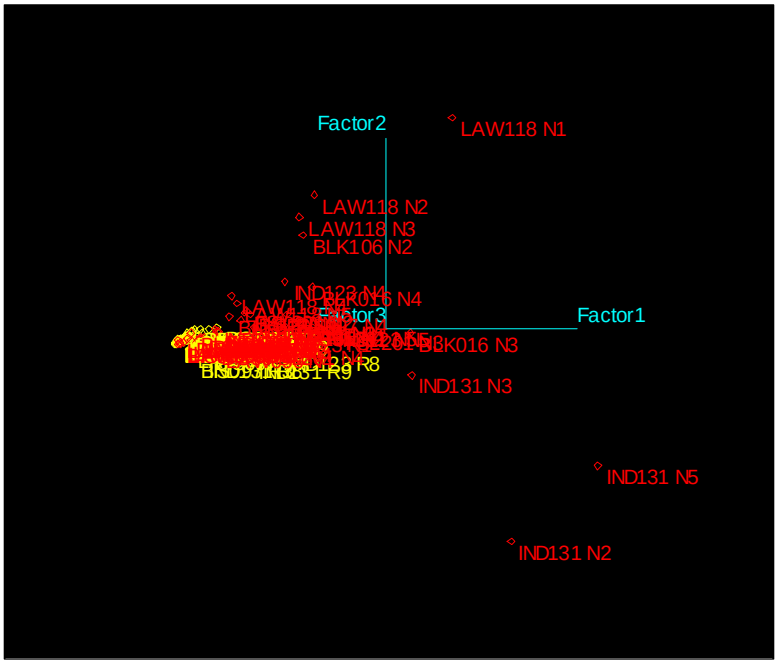

Figure 14. Principal components analysis of combined polar lipid fatty acid methyl ester sterol profiles. Some of the native samples (N, red) are much more spread out than the disturbed samples (R, yellow).

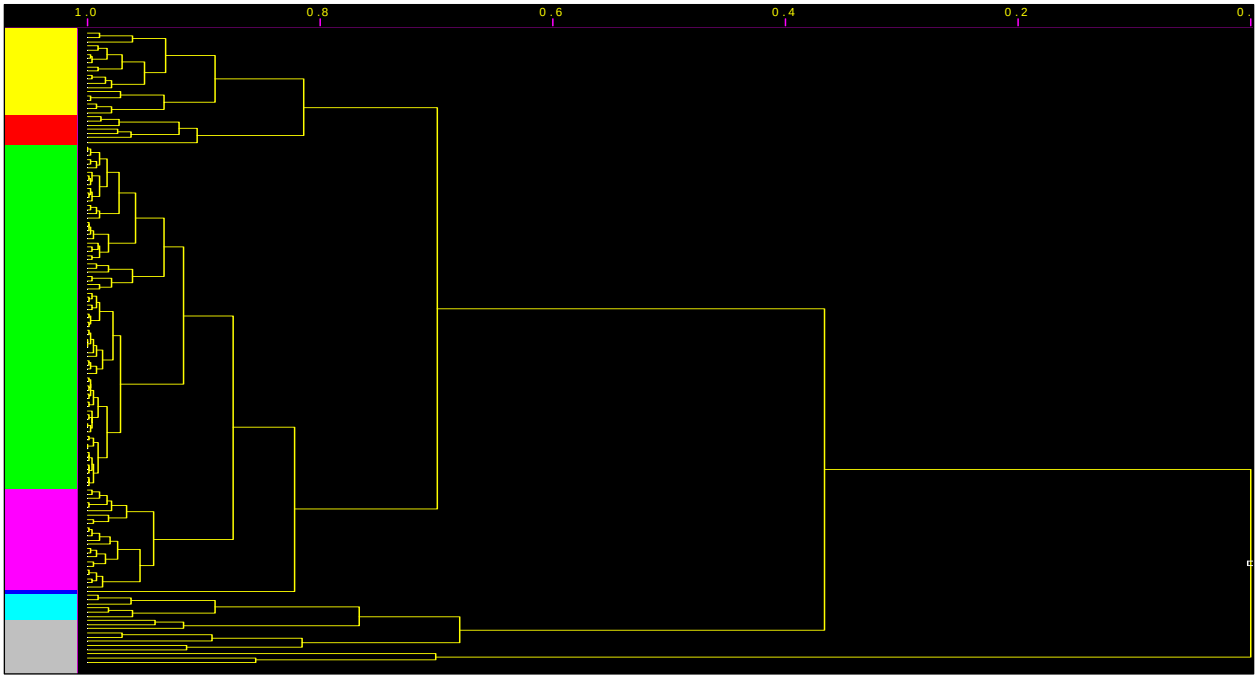

Figure 15. Grand HCA of all measured soil characteristics, including lipid profiles and the other soil characteristics. This dendrogram shows much more structure (i.e., depth of branching) in the clustering than that of the soil lipid data only. The large clusters (green, purple) in the middle, which are composed almost entirely of disturbed (R) samples, have much substructure, as do the different clusters (yellow, red) at the top, which are composed entirely of native (N) samples, and the significant number of more variable samples (gray, light blue) at the bottom, which are mostly native samples.

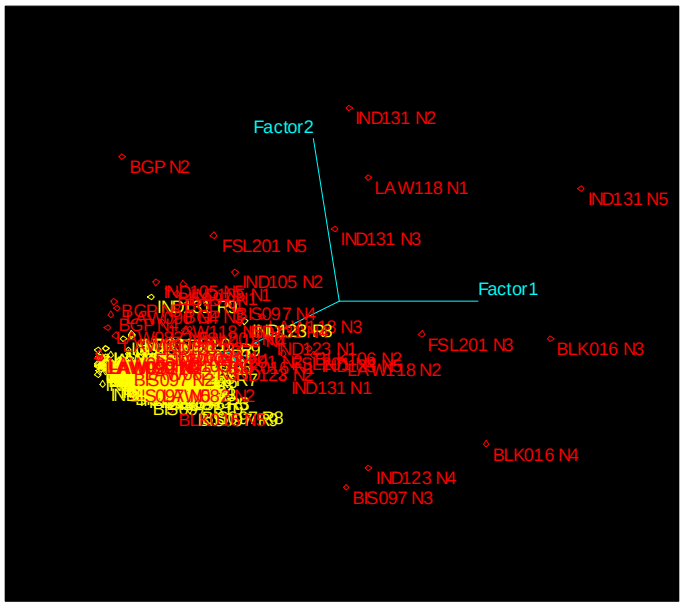

Figure 16. Grand PCA of all measured soil characteristics, including lipid profiles and the other soil characteristics. The native samples (N, red) are more spread out than the disturbed samples (R, yellow). In general, including more variables does not increase the ability to distinguish native and disturbed samples, although this does increase the sub-cluster structure.

Multivariate discrimination of native and disturbed samples

In order to use multivariate techniques to better differentiate between native and disturbed samples, a soft independent modeling of class analogy (SIMCA) analysis using two classes (native and disturbed) was used to ascertain which of the measured variables provided the most discrimination between the classes. Using all measured soil characteristics, the SIMCA model that best differentiated native from disturbed soils from the ten parcel locations used five factors. The misclassification matrix is given in Table 11. On average, 19% of the samples are misclassified, that is, given the SIMCA model that best distinguishes the classes, any one sample is misclassified by the model 19% of the time.

Table 11. SIMCA misclassification matrix for all measured soil characteristics with the first class disturbed and the second class native. Note that of the 151 samples, the three disturbed and one native samples with missing data were excluded from this analysis.

	Pred1	Pred2
Actual1	78	19
Actual2	9	41

The factors that best discriminate between the native and disturbed soils can be determined by looking at the loadings (Figure 17). For the first principal component, factor 1, the total sterols have the largest absolute value of loading (–0.96), while the total PLFAME is also highly weighted. None of the other variables contribute nearly as much.

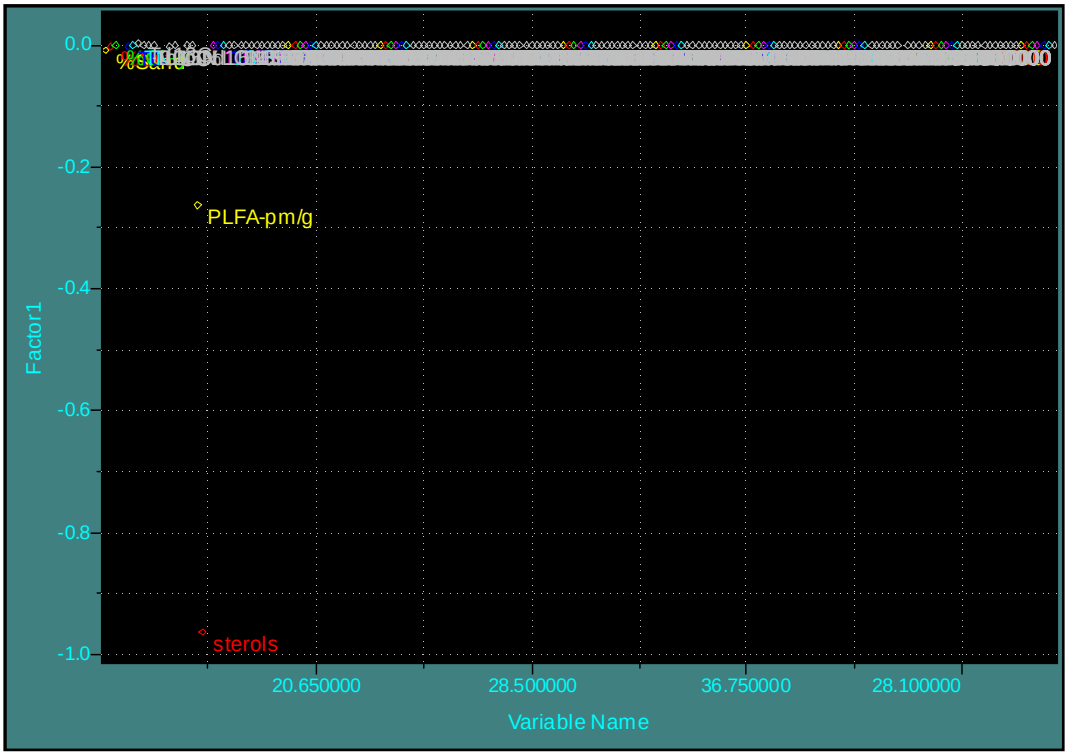

Figure 17. SIMCA model loadings for the first principal component that most discriminates among the native and disturbed samples. The total lipids have the largest absolute values of loading.

A scaled discriminating power analysis of this SIMCA model (Figure 18) shows that many individual lipids and other soil characteristic variables contribute to the discrimination, and no individual characteristic has exceptionally high discriminating power. The lipid with the most discriminating power is the rare PLFAME at retention time 53.30, which occurs in only two disturbed samples at low levels. Two other discriminating PLFAMEs at 33.75 and 32.60 consistently occur at higher levels in native samples.

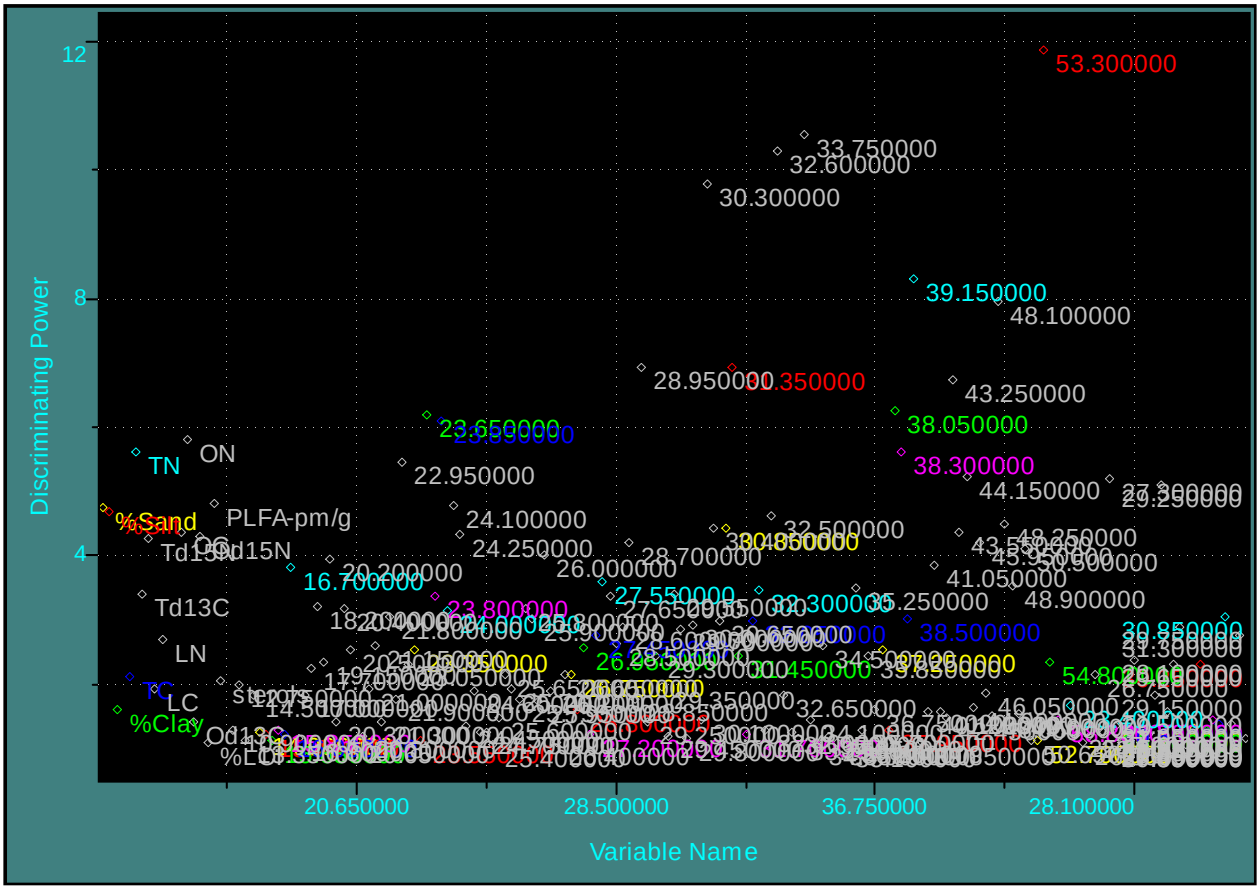

Figure 18. Discriminating power analysis for the derived SIMCA model that best differentiated native from disturbed soil samples. Many individual lipids (named by retention times) and other variables contribute to the discrimination, none of which showed extraordinarily high discriminating power.

There may be information in some of the rarer or low-level lipids, but if these rare data are caused by noise, the interpretation of the multivariate analyses can be misleading. To assess this possibility, the rarer lipids were excluded from analysis. The criteria for exclusion can be developed from the data. Figure 19 shows the results of a rarity analysis for PLFAME, in which the number of excluded PLFAMEs is plotted versus the cutoff criterion. For instance, if the criterion is that each PLFAME should be nonzero in 10 or more samples, the number of PLFAMEs that would be excluded is 50.

As seen in Figure 19, the PLFAME rarity plot exhibits a natural break, a change of slope, at a criterion of between 15 and 20. To be definite as well as somewhat conservative in the subsequent analysis, we only excluded the PLFAMEs that occurred in less than 10% of the samples. That is to say, PLFAMEs that were nonzero in only 15 or fewer of the samples were considered rare. The number of excluded PLFAMEs was 58; the number still

included was 70. For sterols the rarity criterion was taken to be 5, so 23 sterols were excluded (Figure 20).

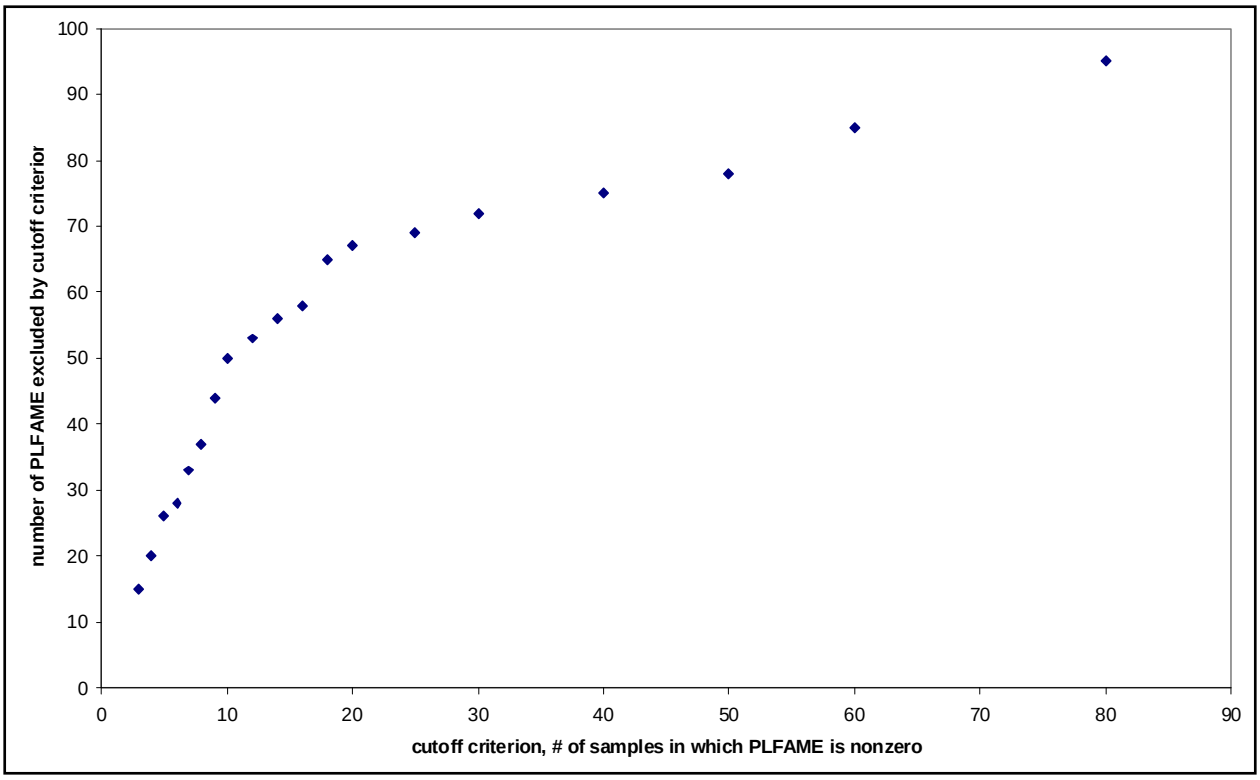

Figure 19. Rarity analysis of PLFAME, exhibiting a change of slope at a criterion of between 15 and 20.

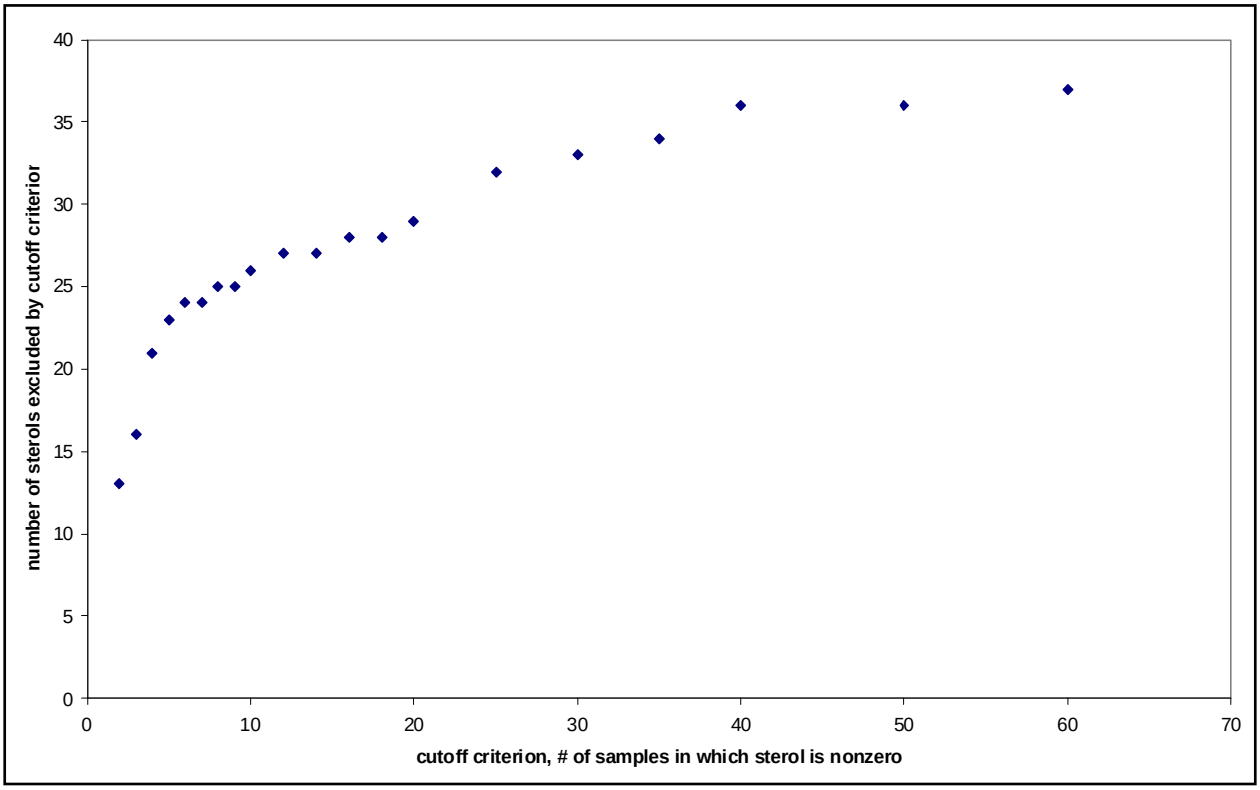

Figure 20. Rarity analysis of sterols, exhibiting a change of slope at a criterion of around 5.

These rarer lipids also tend to be present in lower levels (pmole/gdw). The average percent relative contribution of each PLFAME to the total PLFAME biomass (the mole percentage) was plotted against the number of samples for which that PLFAME was nonzero (Figure 21). Under the suggested criterion of excluding those PLFAMEs that were nonzero in only 15 or fewer of the 151 samples, it can be seen that on average only on the order of 0.01% (i.e. a fraction of 0.0001) of the total PLFAME is excluded. Analogously for sterols the suggested criterion resulted in excluding those sterols that were nonzero in only 5 or fewer of the 151 samples. On average the sterols excluded represented 0.1% of the total sterol amount.

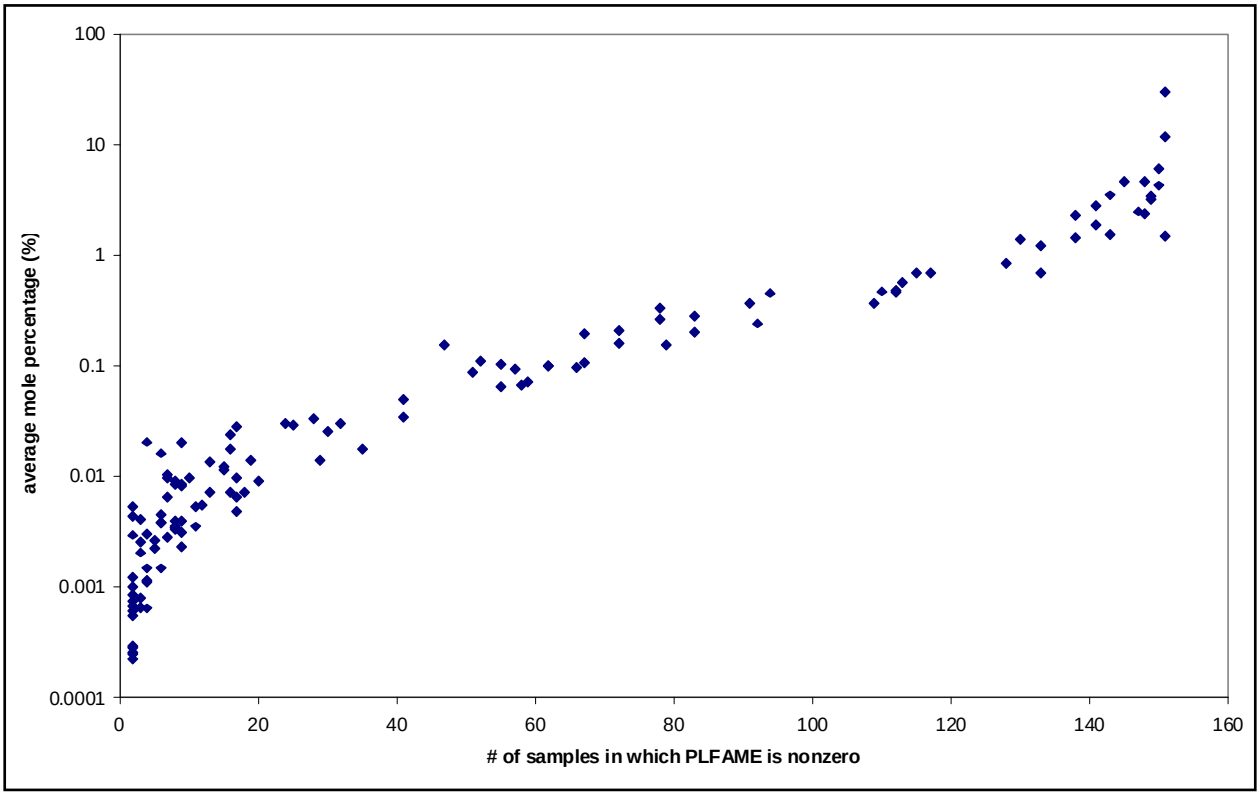

Figure 21. Average percent relative contribution of each PLFAME to the total PLFAME biomass (the mole percentage) versus the number of samples for which that PLFAME was nonzero. Under the suggested criterion of excluding those PLFAMEs that were nonzero in only 15 or fewer of the 151 samples, it can be seen that on average only on the order of 0.01% (i.e. a fraction of 0.0001) of the total biomass is excluded.

Proceeding with a new SIMCA for classification analysis of the native and disturbed samples, the exclusion of the rarer lipids improved the classification. The SIMCA using all other measured data that performed the best used nine factors. The misclassification matrix is given in Table 12. On average fewer than 5% of the samples are misclassified; that is, using the SIMCA model that best distinguishes the two classes, any one sample is misclassified by the model less than 5% of the time.

Table 12. SIMCA model misclassification matrix for all non-rare data with the first class disturbed and the second class native. Note that of the 151 samples, the three disturbed and one native samples with missing data were excluded from this analysis.

	Pred1	Pred2
Actual1	92	5
Actual2	2	48

The scaled discrimination analysis of this SIMCA reveals that, in addition to the total PLFAME and total sterols, some individual lipids provide high discriminating power between native and disturbed samples. As seen in Figure 22, the PLFAME at retention time 27.55 and the sterol at 28.45 provide high discriminating power, followed by a dozen or more variables providing lesser discrimination. The most discriminating PLFAME at 27.55, as yet unidentified by external standards and/or MS libraries, occurs most consistently in the disturbed samples. The most discriminating sterol at 28.45 occurs mostly in the native samples.

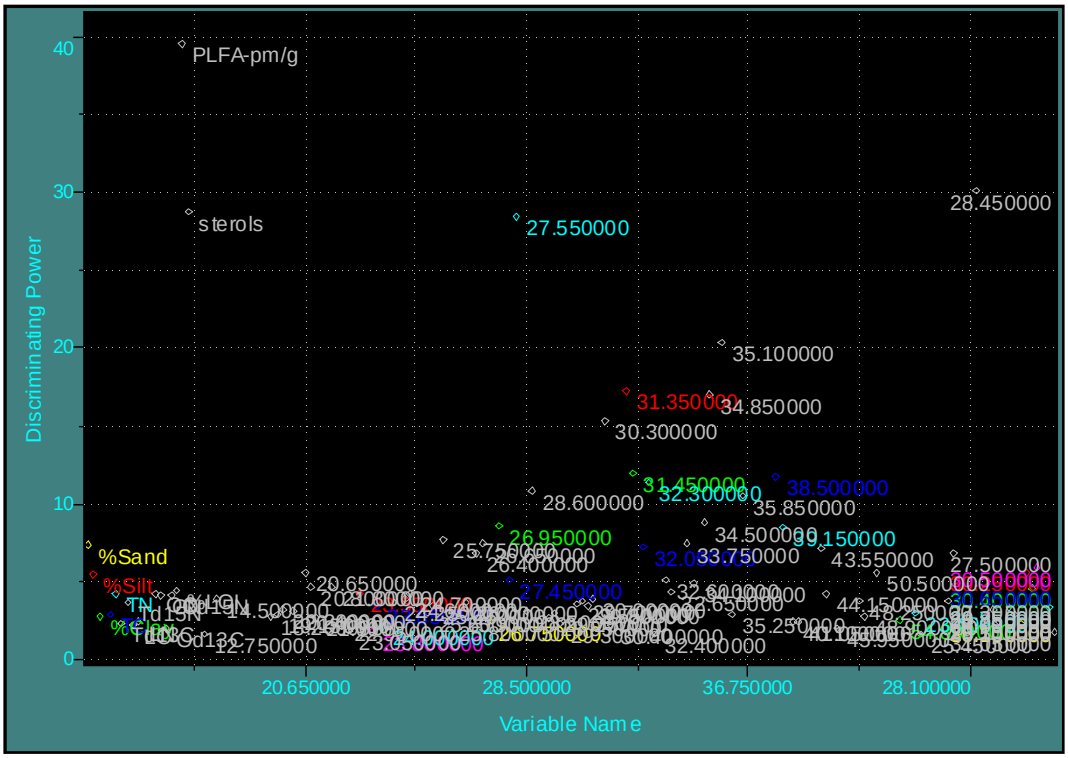

Figure 22. Discriminating power analysis of the SIMCA model that best discriminated native from disturbed soils using all non-rare data. More PLFAMEs (middle-left) than sterols (right) provide high discrimination. Individual lipids are named by retention times.

Table 13. SIMCA interclass distances for native vs. disturbed samples. The distance between the first class disturbed and second class native is 1.07.

	CS1	CS2
CS1	0	1.07
CS2	1.07	0

This class distances is small (Table 13), indicating considerable overlap between the native and disturbed samples; the typical separability

criterion classes are considered separable when the interclass distance is greater than three (Kvalheim and Karstang 1992). Some of this lack of separability may be due to the effects of lumping data from the ten parcel locations, which resulted in larger variability. The effects of location are discussed next.

Contrasting soils by parcel locations

The ten parcels of land span a distance of over 90 km in the Owens Valley. The geological deposits in the valley are due mainly to the erosion of the steep mountains slopes that contain the valley and recent volcanic flows and pyroclastic rocks (Danskin 1998). The deposition of alluvial materials in the valley was influenced by the presence of two structural basins, one around Bishop in the Northern Valley and one in the Lake Owens Basin in the Southern Valley.

Soil texture

The soils in the Owens Valley are largely composed of sand and differ mainly in their relative content of silt (Figure 23).

Danskin (1998) classified soils in the Northern Valley around Laws, CA, as moderately to well-sorted, unconsolidated lenses and layers of sand, silty sand, and gravelly sand, with layers, lenses, or massive beds of silty clay. Most of the soils we characterized from land parcels around in the Northern Valley basin—Laws (LAW082, LAW090, and LAW118), Bishop (BIS097), and Fish Slough (FSL201)—were similar with respect to texture. The Big Pine soils clustered with the Bishop basin soils, but BGP geographically lies at a transition point between the two catchment basins. Blackrock (BLK016) and two of the three Independence soils (IND105 and IND131) group with soils in the Southern Valley. We were not able to further separate the 151 soil samples we characterized into the three model soil categories for the Owens Valley proposed by Danskin (1998) on the basis of soil texture.

Soil lipids

In contrast to soil texture, the chemical profiles showed great variability by location. However, much of this variability was not predictive of location, especially when including native and disturbed samples together (Figure 24). Instead, much of the sample variability means a large spread, so

that locations are not very distinct from each other. For instance, although the Owens River runs roughly north–south in this region, in Figure 24 the southernmost samples are not well distinguished from the northernmost samples.

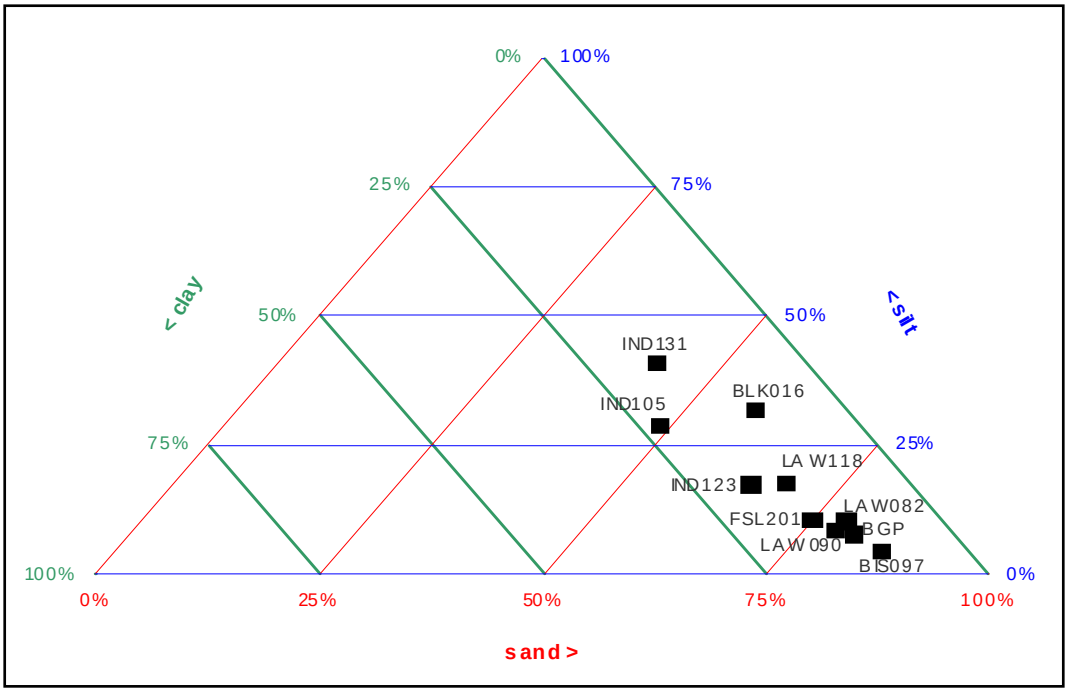

Figure 23. Soils of the ten Owens Valley land parcels characterized and compared by their soil textures.

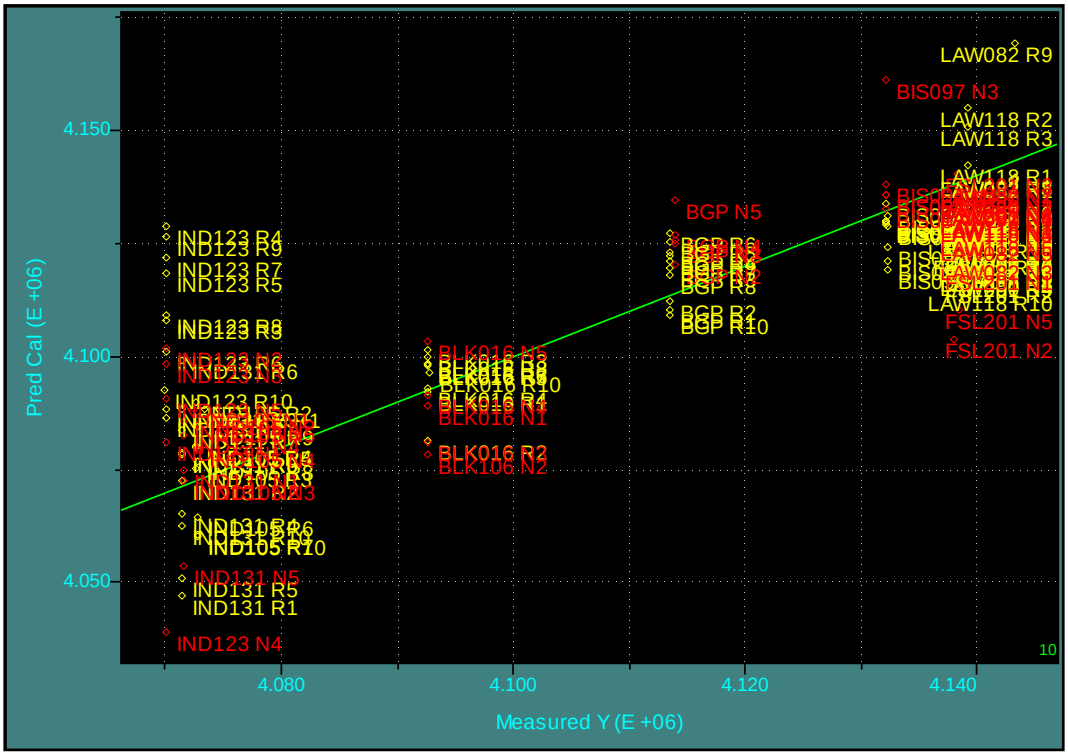

Figure 24. Partial least-squares regression of GPS N reading, using all the measured data (r2 = 0.68). The native (N, red) and disturbed (R, yellow) samples perform about equally in this fit, and the primary loadings for the first few factors are total sterols, total PLFA, and percent sand.

A SIMCA model was derived that used the ten parcel locations as classes. On average, 33% of the locations are misclassified (Table 14). Given the SIMCA model that best differentiates the soils from the ten parcel locations (classes), any one sample is misclassified by the model 33% of the time. Note that for some locations the SIMCA performs quite poorly, for instance the sixth class (IND123) and the first class (BGP) are misclassified the most, while for some locations, notably the third class (BLK016) and the ninth class (LAW090), the predicted classes are quite good.

Table 14. Misclassification matrix for the SIMCA model derived to differentiate soils from the ten parcel locations for all data.

	Pred1	Pred2	Pred3	Pred4	Pred5	Pred6	Pred7	Pred8	Pred9	Pred10
Actual1	6	3	0	3	0	0	0	3	0	0
Actual2	0	12	0	2	0	0	0	0	0	1
Actual3	0	0	13	0	1	0	0	0	0	0
Actual4	2	3	0	8	0	1	0	1	0	1
Actual5	0	0	0	0	12	0	3	0	0	0
Actual6	1	1	1	3	2	5	1	1	0	0
Actual7	0	0	0	0	3	0	12	0	0	0
Actual8	2	1	0	0	0	1	0	9	0	0
Actual9	0	0	0	0	0	0	0	0	13	1
Actual10	0	0	0	1	0	3	0	1	2	8

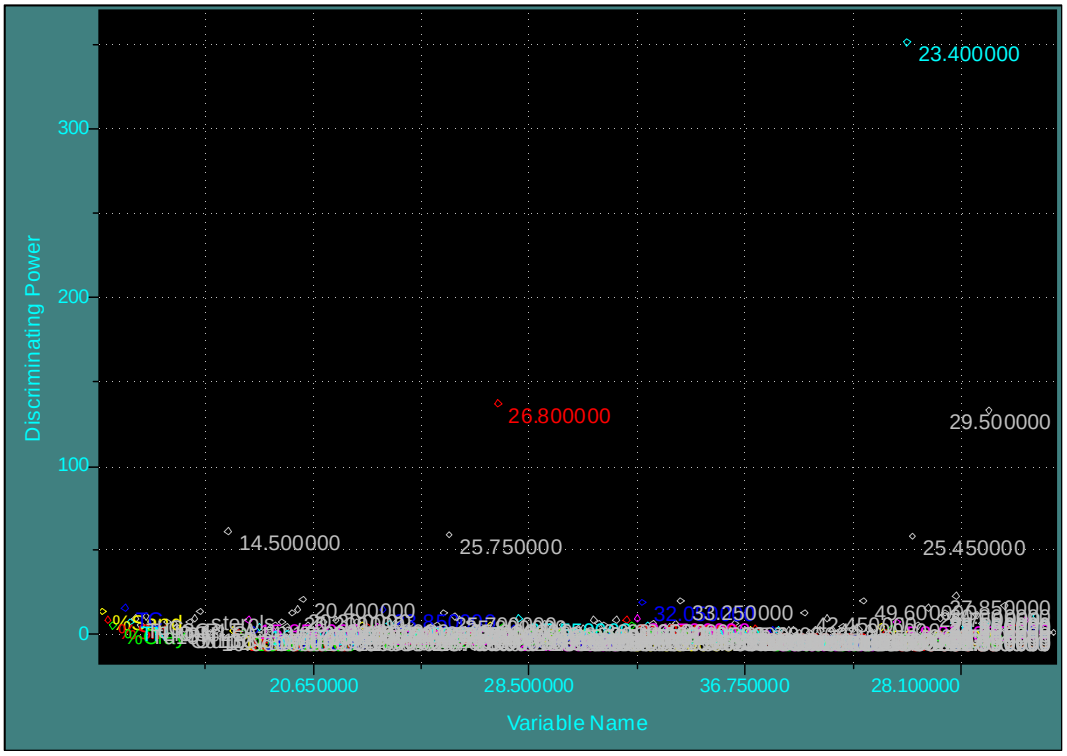

Figure 25. Discriminating power analysis of the SIMCA model derived to differentiate soils from the ten locations using all data. Several individual sterols (right side) and several individual PLFAME (middle-left) provide the most discrimination between locations. Individual lipids are named by retention times.

The most discriminating sterol, with a retention time of 23.40, is as yet unidentified. It occurred strongly in only two samples, namely IND131 and

LAW090. The other highly discriminating sterols are one known related to ergosterol at 29.50 and coprostanol at 25.45. The most highly discriminating PLFAME is unidentified, with a retention time of 26.80. It occurs only in LAW090 samples. The other highly discriminating PLFAMEs are 12:0 at 14.50 and unidentified at 25.75. Ergosterol and related sterols come primarily from fungi, while coprostanol is a marker for untreated human fecal material. The PLFAME 12:0 is one of the lighter ubiquitous components of cell membranes and can exhibit analytical variability, usually due to sampling handling including dilution. This is not the case for these samples; for instance, the mole percentage of 12:0 is not correlated with the PLFAME biomass. Although each of these lipids tends to occur most strongly in only one or a few locations in these samples, their significance is difficult to understand.

The large differences in characteristics between soils supporting native vegetation and those from disturbed areas probably overwhelmed differences between parcel locations when SIMCA models were developed from combined native and disturbed soil characteristics. Additional SIMCA models were derived after segregating data on native soils from those of disturbed soils at each of the ten parcel locations. When SIMCA models were derived using only soil characteristic data on soils supporting native vegetation, six of the ten locations are well classified (Table 15). The other four are misclassified, with an average misclassification rate of a large 55%. For instance, the tenth class, LAW118, is completely misclassified as the fourth class FSL201. The class distances are fairly large if the typical separability criterion classes are considered separable when the interclass distance is greater than three. This criterion is met in 38 of the 90 pairs of the ten classes. Correct classification is only effective if classes are separable, that is, the combination of correct class prediction and good separability is what makes a good classification model.

Table 15. Misclassification matrix for the SIMCA model derived to best separate the ten parcel locations using soil characteristic data only for soils supporting native vegetation.

	Pred1	Pred2	Pred3	Pred4	Pred5	Pred6	Pred7	Pred8	Pred9	Pred10
Actual1	5	0	0	0	0	0	0	0	0	0
Actual2	4	0	0	1	0	0	0	0	0	0
Actual3	0	0	0	0	2	0	3	0	0	0
Actual4	1	0	0	5	0	0	0	0	0	0
Actual5	0	0	0	0	5	0	0	0	0	0
Actual6	0	0	0	2	1	2	0	0	0	0
Actual7	0	0	0	0	3	1	1	0	0	0
Actual8	0	0	0	1	0	0	0	4	0	0
Actual9	1	0	0	0	0	0	0	2	1	0
Actual10	0	0	0	5	0	0	0	0	0	0

Table 16. Interclass distances for the SIMCA model derived to best separate the ten parcel locations using soil characteristic data only for soils supporting native vegetation. For instance, the distance between the first class BGP and second class BIS097 is 2.52. The spurious huge interclass differences for the second class BIS097, the third class BLK016, and the tenth class LAW118 are due to near-singularities in the matrix calculation due to the misclassifications.

	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10
CS1	0	2.52	11.19	1.06	5.28	1.06	0.98	1.54	1.92	4.94
CS2	2.52	0	8.00E+12	1.43	7.9	1.87	1.39	4.89	5.64	3.00E+12
CS3	11.19	8.00E+12	0	3.67	3.39	1.48	0.54	8.13	12.19	7.00E+12
CS4	1.06	1.43	3.67	0	2.22	1.27	0.78	2.98	5.95	0.37
CS5	5.28	7.9	3.39	2.21	0	0.37	0.4	2.5	2.75	5.32
CS6	1.06	1.87	1.48	1.27	0.37	0	1.07	0.7	6.72	1.58
CS7	0.98	1.39	0.54	0.78	0.4	1.07	0	1.53	8.37	0.81
CS8	1.54	4.89	8.13	2.98	2.5	0.7	1.53	0	1.53	4.71
CS9	1.92	5.64	12.19	5.95	2.75	6.72	8.37	1.53	0	6.13
CS10	4.94	3.00E+12	7.00E+12	0.37	5.32	1.58	0.81	4.71	6.13	0

The discriminating power (Figure 25) shows that for the native soil samples, the sterols, including the total sterols, are much more discriminating than the PLFAs. The discriminating power of coprostanol at 25.45 may be due to the presence of consistently high levels only in IND123 and IND131 samples, as well as the highest levels found only in LAW118 samples. Another sterol, related to ergosterol, at 29.50 also provides high discrimination between locations. It occurs in native samples consistently only for BIS097, IND123, and IND131.

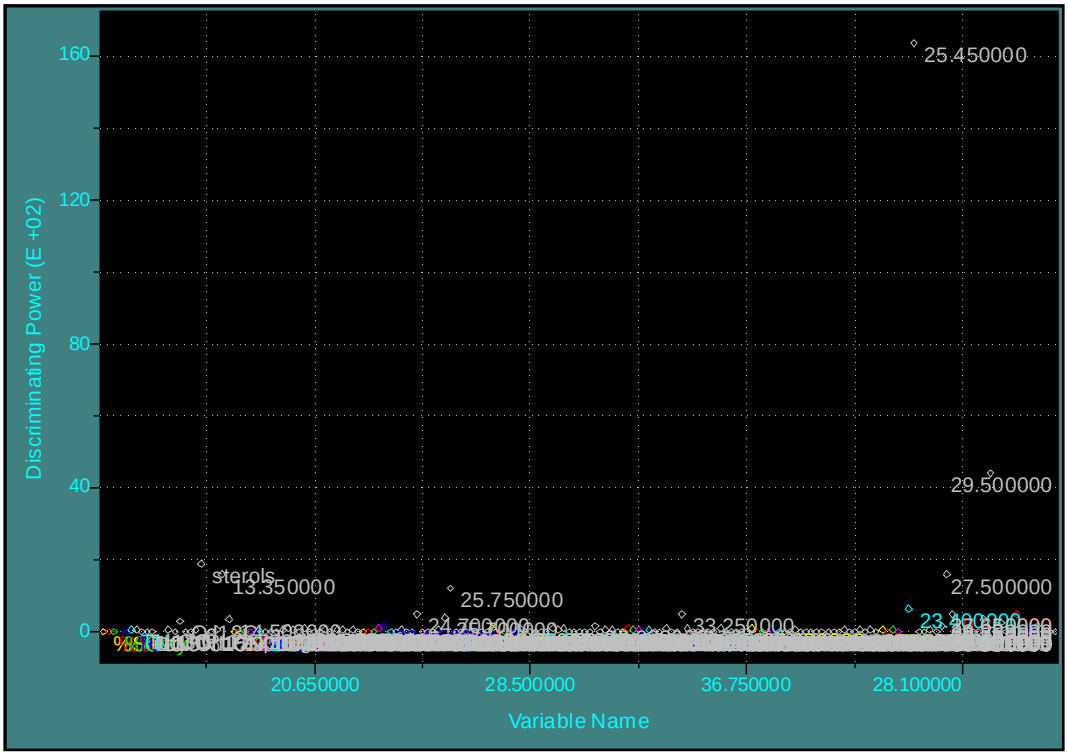

Figure 26. Analysis of the discriminating power for the SIMCA model that best resolved the ten parcel locations using only soil characteristic data from sites supporting native vegetation. Several individual sterols (right side) provide the most discrimination between locations.

The SIMCA model that best differentiated the ten parcel locations using data on soil characteristics only from disturbed sites provided a different perspective. This SIMCA model tends to predict the disturbed locations better on average than the SIMCA model based on native soil characteristics. The average misclassification rate was 21% (Table 17). However, only 24 of the 90 pairs of classes exhibit good separability; the remaining 66 of 90 are not different enough to be separable (Table 18).

Table 17. Misclassification matrix for the SIMCA model that best differentiated the ten parcel locations using soil characteristics of samples collected from disturbed sites.

	Pred1	Pred2	Pred3	Pred4	Pred5	Pred6	Pred7	Pred8	Pred9	Pred10
Actual1	6	0	0	3	0	1	0	0	0	0
Actual2	1	9	0	0	0	0	0	0	0	0
Actual3	0	0	9	0	0	0	0	0	0	0
Actual4	0	0	0	9	0	1	0	0	0	0
Actual5	0	0	0	0	9	0	1	0	0	0
Actual6	0	2	0	2	2	3	1	0	0	0
Actual7	0	0	1	0	1	0	8	0	0	0
Actual8	0	0	0	0	0	0	0	8	0	0
Actual9	0	0	0	0	0	0	0	0	9	1
Actual10	0	0	0	0	0	1	0	1	2	6

Table 18. SIMCA interclass distances for the SIMCA model that best differentiated the ten parcel locations using soil characteristics of samples collected from disturbed sites.

	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10
CS1	0	1.42	2.74	0.82	2.67	0.23	3.07	6.43	1.42	0.65
CS2	1.42	0	4.33	1.15	4.11	0.67	3.99	11.98	4.4	0.66
CS3	2.74	4.33	0	2.93	0.95	1.04	1.46	5.14	2.09	1.71
CS4	0.82	1.15	2.93	0	2.85	0.29	2.9	3.16	1.32	0.26
CS5	2.67	4.11	0.95	2.85	0	1.25	0.74	4.61	2.53	1.91
CS6	0.23	0.67	1.04	0.29	1.25	0	1.23	3.89	0.5	0.22
CS7	3.07	3.99	1.46	2.9	0.74	1.23	0	3.89	2.5	2.07
CS8	6.43	11.98	5.14	3.16	4.61	3.89	3.89	0	1.19	1.57
CS9	1.42	4.4	2.09	1.32	2.53	0.5	2.5	1.19	0	0.34
CS10	0.65	0.66	1.71	0.26	1.91	0.22	2.07	1.57	0.34	0

Total soil sterols and selected individual PLFAMEs are heavily weighted by the SIMCA model that best differentiates the ten parcel locations based on soil characteristics only from the disturbed sites (Figure 27). The discriminating power shows that for the disturbed samples some individual PLFAMEs are much more discriminating than for the native samples. Two of the most highly discriminating PLFAMEs for disturbed samples are the monounsaturates br16:1a at 22.95 and 18:1w5c at 30.00. These PLFAMEs tend to occur in all (or most) of the samples from some locations and also in none (or almost none) of the samples from other locations. For instance, br16:1a occurs at relatively high levels in all of disturbed samples from BGP but none of the IND105 samples, while 18:1w5c occurs at

relatively high levels in all of the LAW090 samples but none of the IND131 samples.

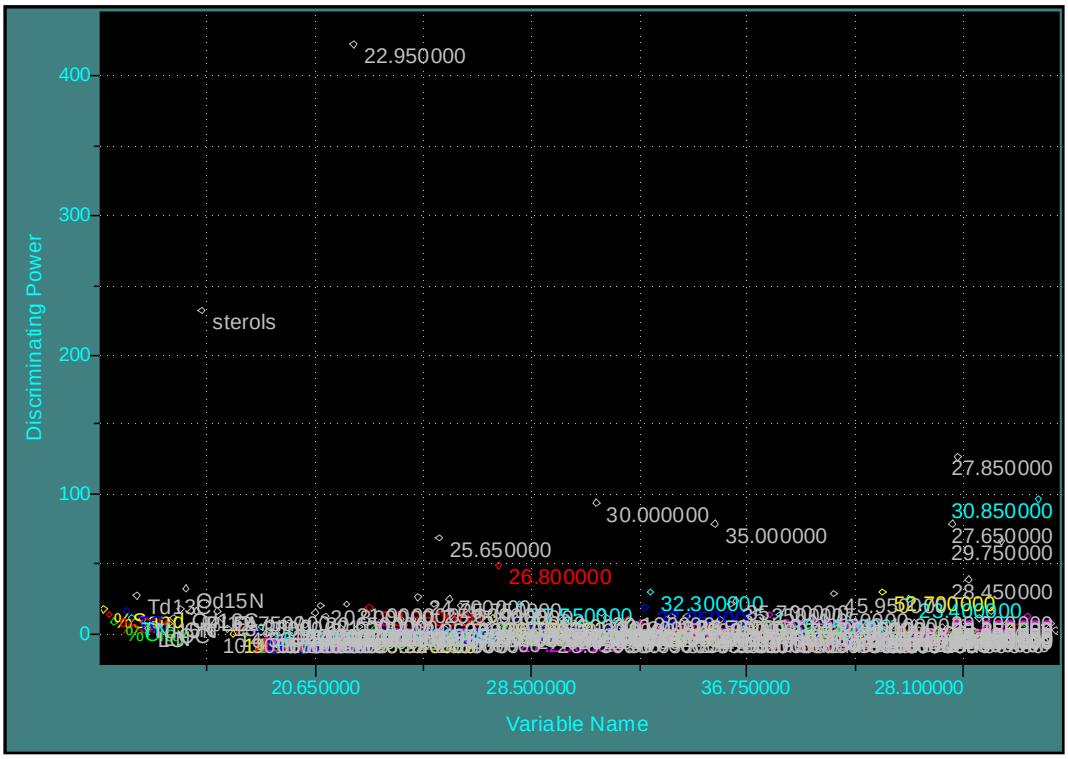

Figure 27. Analysis of the discriminating power of SIMCA model that best differentiated the ten parcel locations using soil characteristics of samples collected from disturbed sites. Individual PLFAMEs, including the monounsaturates br16:1a at retention time 22.95 and 18:1w5c at 30.00, provide the most discrimination between locations, although total sterols also provide high discrimination.

In summary, the amounts and types of lipids are major discriminating factors when all the soil characteristics are used to differentiate the 151 soil samples with respect to parcel location in the Owens Valley and also to differentiate soil supporting native vegetation from soil from a disturbed site. Lipid characteristics of soils supporting native vegetation at each of the ten parcel locations were different from soils in the respective disturbed sites. From another perspective, lipid characteristics of soils supporting native vegetation resolved seven of the ten parcel locations. This may mean that the soils supporting native vegetation in these seven parcels are evolving unique soil microbe–plant relationships. In contrast, the lipid characteristics of disturbed soils from the ten parcel locations were not unique. Disturbance may have reduced the soil microbial community to some common undifferentiated ground state.

4 Discussion of Mycorrhizae

The most well-studied plant–fungal symbiotic relationships are those belonging to the fungal taxa *Glomeromycota*. They are obligate symbionts, which colonize host plant roots from spores, extraradical hyphae, or previously colonized roots. Hyphae grow from colonized roots into the soil and form the extraradical mycelium. Lipid droplets in the hyphae accumulate in the developing spores (Bago et al. 2002). The extraradical mycelium may spread along the root to form new entry points, but it usually spreads out from the host root to form an extensive extraradical mycelium. From the point of mycorrhizal colonization, intercellular (Arum-type colonization) or intracellular (Paris-type colonization) hyphae spread into the root and side branches of hyphae and produce arbuscules, finely branched hyphal structures surrounded by the host plasma membrane. Arbuscules (AM) are short-lived structures believed to have a turnover rate of 1 to 2 weeks and probably are a critical site for nutrient transfer between the symbionts (Smith and Read 1997). At a later stage, the fungus may form vesicles, which are lipid-filled storage structures with a low turnover rate, in intercellular spaces.

Van Aarle and Olsson (2003) used the fatty acid 16:1ω5 as a signature for both *Glomeromycota* AM fungal phospholipids (membrane constituents) and neutral lipids (energy storage) in roots (intraradical mycelium) and in soil (extraradical mycelium). The biomarker for *Gomus*, 16:1ω5, was a minor PLFAME in the Owens Valley soils, and it was not found at higher levels in the native soils relative to the disturbed soils. Other suggested signature fatty acids for AM (Jabaji-Hare 1988, Graham et al. 1995, Bentivenga and Morton 1996, Olsson 1999) occur at lower levels than 16:1ω5 and were not observed in our samples. However, our soil sampling and analyses were designed to survey the physical, chemical, and microbiological soil characteristics, not specifically for mycorrhizae. To better understand the relationships between soil microbial and native plant communities in the Owens Valley the bulk soil characteristics used in the present soil survey should be supplemented with microscopic ultrastructural, biochemical, isotopic and molecular methods specifically designed to provide information on soil-plant-microbe relationships.

Mycorrhizal associations in plants from semi-arid regions have probably been under-reported because of the methods used to search for them (Barrow and Aaltonen 2001). Native grasses and shrubs of semi-arid rangelands of the southwestern U.S. are more extensively colonized by dark septate endophytes (DSE) than by traditional *Gomus* mycorrhizal fungi (Barrow 2003). The incidence of DSE in *Atriplex canescens* collected from southern New Mexico has been shown to be common (Barrow and Aaltonen 2001). Physiologically active roots of these plants are extensively colonized by atypical fungal structures that appear to function as protoplasts, without a distinguishable wall or with very thin hyaline walls. These associations escape detection by methods staining specifically for fungal chitin. They are believed to be active fungal stages that progressed to form stained or melanized septate hyphae and microsclerotia characteristic of DSE fungi within dormant roots. The most conspicuous characteristic of these fungi were the unique associations that formed within sieve elements and the accumulation of massive quantities of lipids. This interface suggests a biologically significant location for carbon transfer between the plant and fungus. The continuous intimate association with all sieve elements, cortical and epidermal cells as well as external extension on the root surface and into the soil indicates that they are systemic and considerably more prevalent than previously thought.

No signature lipids for these DSE have been established. However, we have detected high levels of unusual dioic PLFAMEs in soil samples collected from *Atriplex* root zones. We are currently working with Dr. Jerry Burrows (USDA, ARS, New Mexico State U.) to identify signature lipids of these DSE. Studies in semi-arid Spanish landscapes have shown that mycorrhizal associations are vital for plant survival and that these associations alter leaf gas exchange measurements based on $\delta^{13}C$ and $\delta^{18}O$ (Querejeta et al. 2003). Stable isotopic ratios of these gases have been used as indicators of mycorrhizal infections of plants in the field (Querejeta et al. 2005).

5 Conclusions

Many statistically significant ($\alpha = 0.05$) differences were shown in the characteristics of the 150 surface soils sampled from the ten parcel locations in the Owens Valley. The largest and most frequent differences were shown between soils supporting native vegetation and soils from disturbed areas at each of the ten parcel locations. Soils supporting native vegetation at seven of the ten parcel locations were also shown to differ from each other, suggesting divergent plant–soil microbe associations. Of all the soil characteristics measured, soil lipids best differentiated the soils, with respect to both native vs. disturbed soils and to location of land parcel within the Owens Valley. Both the total levels of soil lipids (PLFAME and sterols) and the compositions of the profiles of individual PLFAMEs and sterols in the soil samples substantially contributed to these differences.

Differences in the levels of total PLFAME indicate differences in soil microbial community biomass, which was usually an order of magnitude higher in soils supporting native vegetation than in soils from disturbed sites. The levels of total sterols were also generally higher in native soils than in disturbed soils. Many differences in the levels of individual PLFAMEs identified by retention times were observed. Although we have unambiguously identified more than half of the 128 PLFAMEs detected in this study, many of the structures and biosynthetic origins of the most discriminating PLFAMEs remain to be determined. Unique dioic PLFAMEs are abundant in soils supporting native vegetation and may serve as biomarkers for dark septate fungal root endophytes, symbiotic associations that may be common to semi-arid vegetation of the southwestern U.S. The profiles of the individual sterols also contributed to the differentiation of the soil samples.

The microbiological characteristics of these soils and their relationships to plant communities are the largest and most frequently encountered differences between soils supporting native plant communities at the ten parcel location in the Owens Valley and their respective disturbed areas. The re-establishment of native plant communities in the valley may be expedited by filling gaps in our basic understanding of the relationships between soil microorganisms and native plant communities. To this end a concerted application of ultrastructural, lipid, isotopic and DNA-based methods would help to fill these gaps and potentially increase the rate of successful revegetation in the valley.

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Appendix A. Data Tables

Site descriptions

Table A1. Latitude, longitude, location, and description of site BGP.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
BGP R-1	386675 E	4113482 N	R	dead vegetation	*Amsinkia* sp.	fiddleneck
BGP R-2	386683 E	4113482 N	R	dead vegetation	*Amsinkia* sp.	fiddleneck
BGP R-3	386692 E	4113482 N	R	dead vegetation	*Amsinkia* sp.	fiddleneck
BGP R-4	386702 E	4113483 N	R	bare ground		
BGP R-5	386714 E	4113483 N	R	bare ground		
BGP R-6	386727 E	4113484 N	R	bare ground		
BGP R-7	386741 E	4113485 N	R	bare ground		
BGP R-8	386756 E	4113486 N	R	bare ground		
BGP R-9	386774 E	4113486 N	R	bare ground		
BGP R-10	386789 E	4113486 N	R	bare ground		
BGP N-1	386486 E	4113919 N	N	Under Shrub	*Ericameria nauseosus*	rubber rabbitbrush
BGP N-2	386482 E	4113926 N	N	Under Shrub	*Ericameria nauseosus*	rubber rabbitbrush
BGP N-3	386477 E	4113942 N	N	Under Shrub	*Ericameria nauseosus*	rubber rabbitbrush
BGP N-4	386474 E	4113957 N	N	Under Shrub	*Ericameria nauseosus*	rubber rabbitbrush
BGP N-5	386467 E	4113962 N	N	Under Shrub	*Ericameria nauseosus*	rubber rabbitbrush

Table A2. Latitude, longitude, location, and description of site BIS097.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
BIS097 R-1	376980 E	4132141 N	R	dead vegetation	Gilia sp.	Gilia
BIS097 R-2	376984 E	4132155 N	R	dead vegetation	*Gilia sp.*	Gilia
BIS097 R-3	376986 E	4132169 N	R	dead vegetation	*Gilia sp.*	Gilia
BIS097 R-4	376990 E	4132192 N	R	dead vegetation	Gilia sp.	Gilia
BIS097 R-5	376990 E	4132209 N	R	dead vegetation	Gilia sp.	Gilia
BIS097 R-6	376989 E	4132230 N	R	bare ground		
BIS097 R-7	376989 E	4132252 N	R	bare ground		
BIS097 R-8	376992 E	4132265 N	R	dead vegetation	Gilia sp.	Gilia
BIS097 R-9	376991 E	4132279 N	R	dead vegetation	Gilia sp.	Gilia
BIS097 R-10	376995 E	4132303 E	R	dead vegetation	Gilia sp.	Gilia
BIS097 N-1	376973 E	4132112 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush
BIS097 N-2	376972 E	4132095 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush
BIS097 N-3	376968 E	4132075 N	N	under shrub	*Atriplex canescens*	fourwing saltbush
BIS097 N-4	376955 E	4132074 N	N	under shrub	*Atriplex canescens*	fourwing saltbush
BIS097 N-5	376949 E	4132084 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush

Table A3. Latitude, longitude, location, and description of site BLK016.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
BLK016 R-1	391290 E	4092597 N	R	bare ground		
BLK016 R-2	391298 E	4092610 N	R	bare ground		
BLK016 R-3	391306 E	4092610 N	R	bare ground		
BLK016 R-4	391319 E	4092621 N	R	bare ground		
BLK016 R-5	391326 E	4092648 N	R	bare ground		
BLK016 R-6	391340 E	4092662 N	R	bare ground		
BLK016 R-7	391352 E	4092674 N	R	bare ground		
BLK016 R-8	391367 E	4092694 N	R	bare ground		
BLK016 R-9	391381 E	4092707 N	R	bare ground		
BLK016 R-10	391395 E	4092720 N	R	bare ground		
BLK016 N-1	391222 E	4092609 N	N	Under perennial	*Sporobolus airoides*	Alkali sacaton
BLK016 N-2	391221 E	4092626 N	N	Under Shrub	*Ericameria nauseosus*	rubber rabbitbrush
BLK016 N-3	391230 E	4092632 N	N	Under Shrub	*Ericameria nauseosus*	rubber rabbitbrush
BLK016 N-4	391229 E	4092641 N	N	Under Shrub	*Atriplex torryei*	Nevada saltbush
BLK016 N-5	391225 E	4092645 N	N	Under perennial	*Sporobolus airoides*	alkali sacaton

Table A4. Latitude, longitude, location, and description of site FSL201.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
FSL201 R-1	368298 E	4139145 N	R	under shrub	*Atriplex serenana*	bractscale
FSL201 R-2	367676 E	4138281 N	R	bare ground		
FSL201 R-3	367583 E	4138240 N	R	under shrub	*Atriplex canescens*	fourwing saltbush
FSL201 R-4	367548 E	4138222 N	R	dead vegetation	Amsinkia sp.	fiddle neck
FSL201 R-5	367503 E	4138200 N	R	dead vegetation	Gilia sp.	Gilia
FSL201 R-6	367539 E	4138158 N	R	bare ground		
FSL201 R-7	367568 E	4138134 N	R	bare ground		
FSL201 R-8	367609 E	4138102 N	R	bare ground		
FSL201 R-9	367641 E	4138047 N	R	bare ground		
FSL201 R-10	367680 E	4138047 N	R	bare ground		
FSL201 N-1	367878 E	4138007 N	N	under shrub	*Artemisia tridentata*	big sagebrush
FSL201 N-2	367883 E	4138005 N	N	under vegetation	*Glycyrrhiza lepidota*	licorice
FSL201 N-3	367579 E	4138377 N	N	under shrub	*Atriplex canescens*	fourwing saltbush
FSL201 N-4	367546 E	4138404 N	N	under shrub	*Atriplex canescens*	fourwing saltbush
FSL201 N-5	367547 E	4138432 N	N	under shrub	*Atriplex canescens*	fourwing saltbush
FSL201 N-6	367542 E	4138455 N	N	under shrub	*Atriplex canescens*	fourwing saltbush

Table A5. Latitude, longitude, location, and description of site IND105.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
IND105 R-1	395450 E	4073327 E	R	bare ground*		
IND105 R-2	395707 E	4072660 N	R	bare ground*		
IND105 R-3	395699 E	4072673 N	R	bare ground*		
IND105 R-4	395688 E	4072697 N	R	bare ground*		
IND105 R-5	395687 E	4072710 N	R	bare ground*		
IND105 R-6	395679 E	4072734 N	R	bare ground*		
IND105 R-7	395675 E	4072752 N	R	bare ground*		
IND105 R-8	395670 E	4072765 N	R	bare ground*		
IND105 R-9	395665 E	4072785 N	R	bare ground*		
IND105 R-10	395662 E	4072803 N	R	bare ground*		
IND105 N-1	395657 E	4072560 N	N	Under Shrub	*Atriplex torryei*	Nevada saltbush
IND105 N-2	395652 E	4072874 N	N	Under Shrub	*Atriplex torryei*	Nevada saltbush
IND105 N-3	395651 E	4072888 N	N	Under Shrub	*Atriplex torryei*	Nevada saltbush
IND105 N-4	395648 E	4072902 N	N	Under Shrub	*Atriplex torryei*	Nevada saltbush
IND105 N-5	395642 E	4072915 N	N	Under Shrub	*Atriplex torryei*	Nevada saltbush
*Samples taken on bare ground but usually in midst of many seedling *Atriplex torreyi* shrubs						

Table A6. Latitude, longitude, location, and description of site IND123.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
IND123 R-1	396147 E	4070112 N	R	dead vegetation	*mixed ground cover**	
IND123 R-2	396403 E	4070110 N	R	bare ground		
IND123 R-3	396380 E	4070104 N	R	dead vegetation	*mixed ground cover**	
IND123 R-4	396361 E	4070098 N	R	bare ground		
IND123 R-5	396345 E	4070090 N	R	dead vegetation	mixed ground cover*	
IND123 R-6	396325 E	4070080 N	R	bare ground		
IND123 R-7	396308 E	4070074 N	R	bare ground		
IND123 R-8	396315 E	4070047 N	R	dead vegetation	mixed ground cover*	
IND123 R-9	396319 E	4070025 N	R	dead vegetation	mixed ground cover*	
IND123 R-10	396328 E	4069995 N	R	bare ground		
IND123 N-1	396427 E	4070143 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND123 N-2	396447 E	4070145 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND123 N-3	396461 E	4070146 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND123 N-4	396487 E	4070140 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND123 N-5	396518 E	4070131 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
*Mentzelia albicaulis (dead), Eriastrum sparsifolia (dead), Cryptantha circumscissa (dead), Lepidium flavum (dead)						

Table A7. Latitude, longitude, location, and description of site IND131.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
IND131 R-1	396847 E	4071374 N	R	bare ground*		
IND131 R-2	396479 E	4071386 N	R	bare ground*		
IND131 R-3	396468 E	4071403 N	R	bare ground*		
IND131 R-4	396454 E	4071417 N	R	bare ground*		
IND131 R-5	396437 E	4071435 N	R	bare ground*		
IND131 R-6	396429 E	4071445 N	R	bare ground*		
IND131 R-7	396424 E	4071460 N	R	bare ground*		
IND131 R-8	396413 E	4071475 N	R	bare ground*		
IND131 R-9	396399 E	4071488 N	R	bare ground*		
IND131 R-10	396386 E	4071492 N	R	bare ground*		
IND131 N-1	396444 E	4071557 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND131 N-2	396465 E	4071562 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND131 N-3	396458 E	4071567 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND131 N-4	396474 E	4071584 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
IND131 N-5	396489 E	4071595 N	N	Under shrub	*Atriplex torryei*	Nevada saltbush
*Samples taken on bare ground but usually in midst of many seedling *Atriplex torreyi* and *Atriplex serenana* shrubs						

Table A8. Latitude, longitude, location, and description of site LAW082.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
LAW082 R-1	380479 E	4143209 N	R	bare ground		
LAW082 R-2	380493 E	4143210 N	R	bare ground		
LAW082 R-3	380507 E	4143209 N	R	bare ground		
LAW082 R-4	380519 E	4143207 N	R	bare ground		
LAW082 R-5	380530 E	4143204 N	R	bare ground		
LAW082 R-6	380546 E	4143201 N	R	bare ground		
LAW082 R-7	380564 E	4143202 N	R	bare ground		
LAW082 R-8	380584 E	4143205 N	R	bare ground		
LAW082 R-9	380604 E	4143206 N	R	bare ground		
LAW082 R-10	380622 E	4143205 N	R	bare ground		
LAW082 N-1	380442 E	4143046 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush
LAW082 N-2	380455 E	4143044 N	N	under shrub	*Sarcobatus vermiculatus*	greasewood
LAW082 N-3	380477 E	4143031 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush
LAW082 N-4	380490 E	4143031 N	N	under shrub	*Sarcobatus vermiculatus*	greasewood
LAW082 N-5	380500 E	4143032 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush

Table A9. Latitude, longitude, location, and description of site LAW090.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
LAW090 R-1	382297 E	4142648 N	R	dead vegetation	*Salsola tragus*	tumbleweed
LAW090 R-2	382316 E	4142646 N	R	dead vegetation	*Salsola tragus*	tumbleweed
LAW090 R-3	382348 E	4142646 N	R	dead vegetation	*Salsola tragus*	tumbleweed
LAW090 R-4	382382 E	4142649 N	R	dead vegetation	Salsola tragus	tumbleweed
LAW090 R-5	382411 E	4142650 N	R	dead vegetation	Salsola tragus	tumbleweed
LAW090 R-6	382244 E	4142650 N	R	bare sand		
LAW090 R-7	382236 E	4142648 N	R	bare sand		
LAW090 R-8	382225 E	4142644 N	R	bare sand		
LAW090 R-9	382212 E	4142642 N	R	bare sand		
LAW090 R-10	382200 E	4142639 N	R	bare sand		
LAW090 N-1	382261 E	4142821 N	N	under shrub	*Atriplex confertifolia*	shadscale
LAW090 N-2	382242 E	4142820 N	N	under shrub	*Ceratoides lanata*	winter fat
LAW090 N-3	382217 E	4142814 N	N	under shrub	*Atriplex confertifolia*	shadscale
LAW090 N-4	382179 E	4142811 N	N	under shrub	*Ceratoides lanata*	winter fat
LAW090 N-5	382155 E	4142819 N	N	under shrub	*Atriplex confertifolia*	shadscale

Table A10. Latitude, longitude, location, and description of site LAW118.						
Sample Name	GPS UTM Coordinates		Revegetative Native	Location of sample	Flora genus and species	Flora common name
LAW118 R-1	382119 E	4139195 N	R	bare ground		
LAW118 R-2	382112 E	4139183 N	R	bare ground		
LAW118 R-3	382107 E	4139173 N	R	bare ground		
LAW118 R-4	382098 E	4139153 N	R	bare ground		
LAW118 R-5	382092 E	4139136 N	R	bare ground		
LAW118 R-6	382089 E	4139123 N	R	bare ground		
LAW118 R-7	382085 E	4139098 N	R	bare ground		
LAW118 R-8	382084 E	4139070 N	R	bare ground		
LAW118 R-9	382085 E	4139047 N	R	bare ground		
LAW118 R-10	382077 E	4139024 N	R	bare ground		
LAW118 N-1	382216 E	4139127 N	N	under shrub	*Atriplex torreyi*	Nevada saltbush
LAW118 N-2	382221 E	4139120 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush
LAW118 N-3	382233 E	4139111 N	N	under shrub	*Atriplex torreyi*	Nevada saltbush
LAW118 N-4	382241 E	4139106 N	N	under shrub	*Ericameria nauseosus*	rubber rabbitbrush
LAW118 N-5	382249 E	4139106 N	N	under shrub	*Atriplex torreyi*	Nevada saltbush

Soil classifications and plant communities

Table A11. USGS Soil Classifications and Plant Communities.

Location	Sample Code	USGS Soil Classification	Vegetation	USGS Plant Community
BGP	N1	Qoa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BGP	N2	Qoa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BGP	N3	Qoa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BGP	N4	Qoa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BGP	N5	Qoa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BIS097	N1	Qoa, Qa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BIS097	N2	Qoa, Qa	*Atriplex cansecans* (Fourwing saltbush)**	High-ground-water-alkaline scrub/Dryland alkaline scrub***
BIS097	N3	Qoa, Qa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BIS097	N4	Qoa, Qa	*Atriplex cansecans* (Fourwing saltbush)**	High-ground-water-alkaline scrub/Dryland alkaline scrub***
BIS097	N5	Qoa, Qa	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BLK016	N1	Qa, Qfl	*Sporobolus airoides* (Alkali sacatoon)	High-ground-water alkaline meadow
BLK016	N2	Qa, Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BLK016	N3	Qa, Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
BLK016	N4	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
BLK016	N5	Qa, Qfl	*Sporobolus airoides* (Alkali sacatoon)	High-ground-water alkaline meadow
FSL201	N1	Qa	*Artemisia tridentata* (Big sagebrush)	Dryland nonalkaline scrub
FSL201	N2	Qa	*Glycyrrhiza lepidota* (Wild licorice)	High-ground-water alkaline meadow
FSL201	N3	Qa	*Atriplex cansecans* (Fourwing saltbush)**	High-ground-water-alkaline scrub/Dryland alkaline scrub***

Table A11. USGS Soil Classifications and Plant Communities.				
Location	Sample Code	USGS Soil Classification	Vegetation	USGS Plant Community
FSL201	N4	Qa	*Atriplex cansecans* (Fourwing saltbush)**	High-ground-water-alkaline scrub/Dryland alkaline scrub***
FSL201	N5	Qa	*Atriplex cansecans* (Fourwing saltbush)**	High-ground-water-alkaline scrub/Dryland alkaline scrub***
FSL201	N6	Qa	*Atriplex cansecans* (Fourwing saltbush)**	High-ground-water-alkaline scrub/Dryland alkaline scrub***
FSL201	R1*	Qa	*Atriplex serenana* (bractscale)**	Dryland alkaline scrub****
IND105	N1	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND105	N2	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND105	N3	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND105	N4	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND105	N5	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N1	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N2	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N3	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N4	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND123	N5	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N1	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N2	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N3	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N4	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub
IND131	N5	Qa, Qfl	*Atriplex torryei* (Nevada saltbush)	High-ground-water-alkaline scrub

Table A11. USGS Soil Classifications and Plant Communities.				
Location	Sample Code	USGS Soil Classification	Vegetation	USGS Plant Community
LAW082	N1	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
LAW082	N2	Qfl	*Sarcobatus vermiculatus* (Greasewood)	High-ground-water-alkaline scrub
LAW082	N3	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
LAW082	N4	Qfl	*Sarcobatus vermiculatus* (Greasewood)	High-ground-water-alkaline scrub
LAW082	N5	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
LAW090	N1	Qfl	*Atriplex confertifolia* (Shadscale)	Dry alkaline scrub
LAW090	N2	Qfl	*Ceratoides lanata* (winterfat)	Dry alkaline scrub
LAW090	N3	Qfl	*Atriplex confertifolia* (Shadscale)	Dry alkaline scrub
LAW090	N4	Qfl	*Ceratoides lanata* (winterfat)	Dry alkaline scrub
LAW090	N5	Qfl	*Atriplex confertifolia* (Shadscale)	Dry alkaline scrub
LAW118	N1	Qfl	*Atriplex torreyi* (Nevada saltbush)	High-ground-water-alkaline scrub
LAW118	N2	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
LAW118	N3	Qfl	*Atriplex torreyi* (Nevada saltbush)	High-ground-water-alkaline scrub
LAW118	N4	Qfl	*Ericameria nauseosus* (Rubber rabbitbrush)	High-ground-water-alkaline scrub
LAW118	N5	Qfl	*Atriplex torreyi* (Nevada saltbush)	High-ground-water-alkaline scrub
* R-1 included in table due to sample being taken under unique shrub **These shrubs not listed in USGS table ***Designation of plant community assumed, possible transition area between communities ****Designation of plant community assumed due to similarity of *Atriplex* species found therin.				

Soil texture

Table A12. Soil texture at site BGP.				
Sample Name	%Sand	%Silt	%Clay	Classification
BGP R-1	72.0	10.0	18.0	Sandy Loam
BGP R-2	74.0	12.0	14.0	Sandy Loam
BGP R-3	78.0	12.0	10.0	Sandy Loam
BGP R-4	80.0	8.0	12.0	Sandy Loam
BGP R-5	84.0	6.0	10.0	Loamy Sand
BGP R-6	84.0	4.0	12.0	Loamy Sand
BGP R-7	80.0	8.0	12.0	Sandy Loam
BGP R-8	86.0	4.0	10.0	Loamy Sand
BGP R-9	84.0	4.0	12.0	Loamy Sand
BGP R-10	74.0	10.0	16.0	Sandy Loam
BGP N-1	84.0	6.0	10.0	Loamy Sand
BGP N-2	84.0	6.0	10.0	Loamy Sand
BGP N-3	82.0	10.0	8.0	Loamy Sand
BGP N-4	80.0	10.0	10.0	Loamy Sand
BGP N-5	88.0	6.0	6.0	Sand

Table A13. Soil texture at site BIS097.				
Sample Name	%Sand	%Silt	%Clay	Classification
BIS097 R-1	88.0	2.0	10.0	Loamy Sand
BIS097 R-2	88.0	2.0	10.0	Loamy Sand
BIS097 R-3	86.0	4.0	10.0	Loamy Sand
BIS097 R-4	88.0	4.0	8.0	Loamy Sand
BIS097 R-5	80.0	10.0	10.0	Loamy Sand
BIS097 R-6	70.0	16.0	14.0	Sandy Loam
BIS097 R-7	88.0	2.0	10.0	Loamy Sand
BIS097 R-8	84.0	4.0	12.0	Loamy Sand
BIS097 R-9	74.0	8.0	18.0	Sandy Loam
BIS097 R-10	88.0	2.0	10.0	Loamy Sand
BIS097 N-1	88.0	4.0	8.0	Loamy Sand
BIS097 N-2	90.0	4.0	6.0	sand
BIS097 N-3	92.0	4.0	4.0	sand
BIS097 N-4	88.0	2.0	10.0	Loamy Sand
BIS097 N-5	92.0	2.0	6.0	sand

Table A14. Soil texture at site BLK016.				
Sample Name	%Sand	%Silt	%Clay	Classification
BLK016 R-1	60.0	32.0	8.0	Sandy Loam
BLK016 R-2	52.0	36.0	12.0	Loam
BLK016 R-3	60.0	28.0	12.0	Sandy Loam
BLK016 R-4	52.0	42.0	6.0	Sandy Loam
BLK016 R-5	50.0	44.0	6.0	Sandy Loam
BLK016 R-6	70.0	22.0	8.0	Sandy Loam
BLK016 R-7	50.0	40.0	10.0	Loam
BLK016 R-8	76.0	18.0	6.0	Loamy Sand
BLK016 R-9	60.0	30.0	10.0	Sandy Loam
BLK016 R-10	52.0	42.0	6.0	Sandy Loam
BLK016 N-1	52.0	40.0	8.0	Loam
BLK016 N-2	52.0	28.0	20.0	Loam
BLK016 N-3	46.0	34.0	20.0	Loam
BLK016 N-4	54.0	32.0	14.0	Sandy Loam
BLK016 N-5	80.0	10.0	10.0	Loamy Sand

Table A15. Soil texture at site FSL201.				
Sample Name	%Sand	%Silt	%Clay	Classification
FSL201 R-1	82.0	4.0	14.0	Sandy Loam
FSL201 R-2	78.0	6.0	16.0	Sandy Loam
FSL201 R-3	88.0	4.0	8.0	Loamy Sand
FSL201 R-4	62.0	16.0	22.0	Sandy Clay Loam
FSL201 R-5	80.0	10.0	10.0	Loamy Sand
FSL201 R-6	78.0	8.0	14.0	Sandy Loam
FSL201 R-7	80.0	6.0	14.0	Sandy Loam
FSL201 R-8	64.0	24.0	12.0	Sandy Loam
FSL201 R-9	70.0	12.0	18.0	Sandy Loam
FSL201 R-10	76.0	8.0	16.0	Sandy Loam
FSL201 N-1	72.0	8.0	20.0	Sandy Clay Loam
FSL201 N-2	74.0	8.0	18.0	Sandy Loam
FSL201 N-3	80.0	10.0	10.0	Loamy Sand
FSL201 N-4	82.0	8.0	10.0	Loamy Sand
FSL201 N-5	58.0	24.0	18.0	Sandy Loam
FSL201 N-6	74.0	14.0	12.0	Sandy Loam

Table A16. Soil texture at site IND105.				
Sample Name	%Sand	%Silt	%Clay	Classification
IND105 R-1	50.0	30.0	20.0	Loam
IND105 R-2	54.0	22.0	24.0	Sandy Loam
IND105 R-3	58.0	14.0	28.0	Sandy Clay Loam
IND105 R-4	36.0	42.0	22.0	Loam
IND105 R-5	60.0	16.0	24.0	Sandy Clay Loam
IND105 R-6	32.0	42.0	26.0	Loam
IND105 R-7	30.0	42.0	28.0	Clay Loam
IND105 R-8	36.0	40.0	24.0	Loam
IND105 R-9	40.0	34.0	26.0	Loam
IND105 R-10	36.0	44.0	20.0	Loam
IND105 N-1	48.0	30.0	22.0	Loam
IND105 N-2	60.0	20.0	20.0	Sandy Clay Loam
IND105 N-3	68.0	14.0	18.0	Sandy Loam
IND105 N-4	64.0	20.0	16.0	Sandy Loam
IND105 N-5	60.0	20.0	20.0	Sandy Clay Loam

Table A17. Soil texture at site IND123.				
Sample Name	%Sand	%Silt	%Clay	Classification
IND123 R-1	40.0	34.0	26.0	Loam
IND123 R-2	54.0	20.0	26.0	Sandy Clay Loam
IND123 R-3	70.0	10.0	20.0	Sandy Clay Loam
IND123 R-4	88.0	2.0	10.0	Loamy Sand
IND123 R-5	80.0	4.0	16.0	Sandy Loam
IND123 R-6	66.0	8.0	26.0	Sandy Clay Loam
IND123 R-7	74.0	8.0	18.0	Sandy Loam
IND123 R-8	60.0	22.0	18.0	Sandy Loam
IND123 R-9	76.0	10.0	14.0	Sandy Loam
IND123 R-10	36.0	44.0	20.0	Loam
IND123 N-1	58.0	28.0	14.0	Sandy Loam
IND123 N-2	70.0	10.0	20.0	Sandy Clay Loam
IND123 N-3	74.0	8.0	18.0	Sandy Loam
IND123 N-4	62.0	18.0	20.0	Sandy Clay Loam
IND123 N-5	62.0	32.0	6.0	Sandy Loam

Table A18. Soil texture at site IND131.				
Sample Name	%Sand	%Silt	%Clay	Classification
IND131 R-1	32.0	54.0	14.0	Silty Loam
IND131 R-2	44.0	46.0	10.0	Loam
IND131 R-3	50.0	40.0	10.0	Loam
IND131 R-4	36.0	44.0	20.0	Loam
IND131 R-5	52.0	38.0	10.0	Loam
IND131 R-6	46.0	40.0	14.0	Loam
IND131 R-7	40.0	40.0	20.0	Loam
IND131 R-8	28.0	50.0	22.0	Silty Loam
IND131 R-9	22.0	58.0	20.0	Silty Loam
IND131 R-10	22.0	58.0	20.0	Silty Loam
IND131 N-1	56.0	32.0	12.0	Sandy Loam
IND131 N-2	30.0	50.0	20.0	Silty Loam
IND131 N-3	54.0	28.0	18.0	Sandy Loam
IND131 N-4	70.0	16.0	14.0	Sandy Loam
IND131 N-5	54.0	18.0	28.0	Sandy Clay Loam

Table A19. Soil texture at site LAW082.				
Sample Name	%Sand	%Silt	%Clay	Classification
LAW082 R-1	78.0	10.0	12.0	Sandy Loam
LAW082 R-2	66.0	16.0	18.0	Sandy Loam
LAW082 R-3	76.0	10.0	14.0	Sandy Loam
LAW082 R-4	80.0	10.0	10.0	Loamy Sand
LAW082 R-5	80.0	6.0	14.0	Sandy Loam
LAW082 R-6	78.0	6.0	16.0	Sandy Loam
LAW082 R-7	82.0	6.0	12.0	Loamy Sand
LAW082 R-8	70.0	10.0	20.0	Sandy Clay Loam
LAW082 R-9	80.0	6.0	14.0	Sandy Loam
LAW082 R-10	78.0	8.0	14.0	Sandy Loam
LAW082 N-1	84.0	6.0	10.0	Loamy Sand
LAW082 N-2	86.0	6.0	8.0	Loamy Sand
LAW082 N-3	80.0	8.0	12.0	Sandy Loam
LAW082 N-4	82.0	8.0	10.0	Loamy Sand
LAW082 N-5	80.0	8.0	12.0	Sandy Loam

Table A20. Soil texture at site LAW090.				
Sample Name	%Sand	%Silt	%Clay	Classification
LAW090 R-1	76.0	14.0	10.0	Sandy Loam
LAW090 R-2	78.0	10.0	12.0	Sandy Loam
LAW090 R-3	76.0	10.0	14.0	Sandy Loam
LAW090 R-4	74.0	14.0	12.0	Sandy Loam
LAW090 R-5	80.0	10.0	10.0	Loamy Sand
LAW090 R-6	72.0	14.0	14.0	Sandy Loam
LAW090 R-7	74.0	16.0	10.0	Sandy Loam
LAW090 R-8	82.0	8.0	10.0	Loamy Sand
LAW090 R-9	76.0	12.0	12.0	Sandy Loam
LAW090 R-10	78.0	10.0	12.0	Sandy Loam
LAW090 N-1	84.0	6.0	10.0	Loamy Sand
LAW090 N-2	80.0	8.0	12.0	Sandy Loam
LAW090 N-3	80.0	10.0	10.0	Loamy Sand
LAW090 N-4	88.0	4.0	8.0	Loamy Sand
LAW090 N-5	82.0	8.0	10.0	Loamy Sand

Table A21. Soil texture at site LAW118.				
Sample Name	%Sand	%Silt	%Clay	Classification
LAW118 R-1	78.0	10.0	12.0	Sandy Loam
LAW118 R-2	76.0	10.0	14.0	Sandy Loam
LAW118 R-3	74.0	14.0	12.0	Sandy Loam
LAW118 R-4	68.0	16.0	16.0	Sandy Loam
LAW118 R-5	76.0	14.0	10.0	Sandy Loam
LAW118 R-6	60.0	20.0	20.0	Sandy Clay Loam
LAW118 R-7	76.0	8.0	16.0	Sandy Loam
LAW118 R-8	78.0	12.0	10.0	Sandy Loam
LAW118 R-9	60.0	20.0	20.0	Sandy Clay Loam
LAW118 R-10	48.0	32.0	20.0	Loam
LAW118 N-1	58.0	30.0	12.0	Sandy Loam
LAW118 N-2	70.0	18.0	12.0	Sandy Loam
LAW118 N-3	72.0	14.0	14.0	Sandy Loam
LAW118 N-4	62.0	28.0	10.0	Sandy Loam
LAW118 N-5	70.0	18.0	12.0	Sandy Loam

Elemental analysis

Table A22. Elemental analysis of site BGP.											
	RAW		Water-Washed Soil				Cooked				LOI change in mass %
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	Leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	
BGP R-1	19.807	2.157	21.232	0.000	2.129	0.028	2.399	17.408	0.560	1.597	4.07
BGP R-2	33.090	3.216	22.580	10.511	2.192	1.024	1.820	31.270	0.421	2.795	4.36
BGP R-3	24.447	2.250	20.907	3.540	2.004	0.246	2.546	21.901	0.560	1.690	3.82
BGP R-4	14.229	1.474	14.851	0.000	1.497	0.000	2.636	11.592	0.480	0.994	3.43
BGP R-5	39.838	3.761	19.103	20.735	1.782	1.979	2.328	37.510	0.462	3.300	4.87
BGP R-6	15.623	1.535	9.923	5.701	1.030	0.504	1.431	14.192	0.438	1.096	2.89
BGP R-7	40.744	3.882	18.641	22.103	1.883	1.998	3.599	37.145	0.706	3.176	3.91
BGP R-8	21.653	2.244	22.253	0.000	2.306	0.000	1.761	19.891	0.465	1.779	4.75
BGP R-9	15.674	1.600	18.394	0.000	1.933	0.000	1.408	14.265	0.389	1.212	3.58
BGP R-10	23.250	2.493	22.113	1.137	2.191	0.302	1.859	21.391	0.510	1.983	3.73
BGP N-1	21.055	2.055	31.220	0.000	2.394	0.000	3.949	17.106	0.597	1.457	8.91
BGP N-2	23.745	1.986	18.597	5.148	1.630	0.356	4.064	19.681	0.770	1.216	4.21
BGP N-3	16.026	1.572	16.534	0.000	1.630	0.000	2.087	13.938	0.519	1.053	4.09
BGP N-4	10.394	1.043	8.958	1.436	0.899	0.144	2.077	8.317	0.431	0.612	2.09
BGP N-5	9.740	0.993	7.506	2.234	0.776	0.217	2.178	7.562	0.493	0.501	2.85

Table A23. Elemental analysis of site BIS097.											
	RAW		Water-Washed Soil				Cooked				LOI change in mass %
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	Leached C mgC/kg DW	N conc. mgN/kg DW	Leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	
BIS097 R-1	5.753	0.857	6.483	0.000	0.802	0.000	0.287	5.467	0.183	0.673	1.55
BIS097 R-2	9.515	1.176	6.892	2.622	0.823	0.000	0.399	9.116	0.154	1.022	1.90
BIS097 R-3	7.542	0.975	8.000	0.000	0.894	0.000	0.461	7.081	0.173	0.802	1.97
BIS097 R-4	5.903	0.802	6.836	0.000	0.808	0.000	0.461	5.442	0.160	0.643	2.48
BIS097 R-5	15.495	1.695	9.918	5.577	1.041	0.000	1.138	14.356	0.217	1.477	2.86
BIS097 R-6	13.462	2.277	17.055	0.000	1.672	0.000	1.053	12.409	0.438	1.839	3.91
BIS097 R-7	14.853	1.883	16.471	0.000	1.645	0.000	1.181	13.671	0.341	1.542	2.95
BIS097 R-8	10.942	1.226	11.597	0.000	1.155	0.000	0.671	10.271	0.253	0.973	3.16
BIS097 R-9	12.531	1.406	13.831	0.000	1.461	0.000	0.732	11.798	0.236	1.169	3.62
BIS097 R-10	7.262	0.840	7.432	0.000	0.847	0.000	0.407	6.855	0.164	0.676	2.29
BIS097 N-1	10.811	1.236	10.034	0.776	1.155	0.000	1.146	9.665	0.198	1.038	6.67
BIS097 N-2	7.277	0.843	9.848	0.000	1.077	0.000	0.411	6.866	0.153	0.691	1.94
BIS097 N-3	9.225	1.095	0.000	0.000	0.000	0.000	1.003	8.221	0.191	0.904	4.06
BIS097 N-4	8.042	0.952	7.840	0.202	0.855	0.000	0.850	7.192	0.175	0.777	3.05
BIS097 N-5	4.771	0.608	4.633	0.138	0.528	0.000	0.800	3.971	0.133	0.475	1.28

Table A24. Elemental analysis of site BLK016.											
	RAW		Water-Washed Soil				Cooked				LOI
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	Leached C mgC/kg DW	N conc. mgN/kg DW	Leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	change in mass %
BLK016 R-1	67.868	2.630	62.176	5.692	2.146	0.484	46.403	21.465	0.484	2.145	7.43
BLK016 R-2	71.046	1.874	73.006	0.000	1.892	0.000	62.363	8.683	0.397	1.477	6.60
BLK016 R-3	66.442	2.441	52.809	13.633	1.763	0.677	46.951	19.491	0.457	1.984	6.61
BLK016 R-4	67.207	1.790	62.870	4.336	1.684	0.106	54.750	12.457	0.441	1.349	6.05
BLK016 R-5	57.114	1.913	56.353	0.761	1.837	0.076	43.499	13.615	0.396	1.516	7.20
BLK016 R-6	59.300	2.137	62.188	0.000	2.296	0.000	42.922	16.377	0.482	1.655	7.72
BLK016 R-7	71.067	2.748	51.711	19.356	2.117	0.631	47.382	23.685	0.490	2.258	7.08
BLK016 R-8	57.456	2.182	56.635	0.821	1.937	0.245	38.691	18.765	0.515	1.667	6.05
BLK016 R-9	47.309	1.255	58.932	0.000	1.439	0.000	48.141	0.000	0.329	0.927	4.72
BLK016 R-10	60.299	1.605	56.033	4.266	1.583	0.022	46.166	14.133	0.355	1.250	5.17
BLK016 N-1	72.105	3.844	70.887	1.218	3.917	0.000	35.973	36.133	0.813	3.032	12.97
BLK016 N-2	68.433	6.117	86.028	0.000	7.838	0.000	11.497	56.936	1.082	5.035	16.74
BLK016 N-3	81.464	6.232	79.962	1.502	5.699	0.533	14.270	67.194	0.964	5.268	18.61
BLK016 N-4	84.686	5.464	80.239	4.448	4.912	0.552	31.198	53.488	0.831	4.632	17.08
BLK016 N-5	60.697	3.268	63.393	0.000	3.316	0.000	37.441	23.256	0.826	2.442	12.06

Table A25. Elemental analysis of site FSL201.											
	RAW		Water-Washed Soil				Cooked				LOI
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	change in mass %
FSL201 R-1	16.575	1.317	16.221	0.354	1.160	0.156	7.419	9.156	0.418	0.899	3.16
FSL201 R-2	17.849	1.226	17.893	0.000	1.189	0.037	8.707	9.142	0.452	0.773	2.71
FSL201 R-3	14.129	1.228	11.321	2.808	1.009	0.220	2.699	11.430	0.306	0.922	2.41
FSL201 R-4	25.174	1.976	9.978	15.196	0.872	1.103	5.099	20.075	0.578	1.397	5.07
FSL201 R-5	8.644	0.772	10.460	0.000	0.887	0.000	2.614	6.030	0.339	0.434	2.49
FSL201 R-6	13.765	1.276	19.209	0.000	1.648	0.000	3.130	10.635	0.425	0.851	3.74
FSL201 R-7	14.228	1.404	9.769	4.459	0.995	0.409	1.212	13.016	0.349	1.055	2.25
FSL201 R-8	11.773	1.059	12.012	0.000	1.147	0.000	2.637	9.136	0.372	0.687	4.09
FSL201 R-9	10.226	0.819	11.587	0.000	1.004	0.000	2.442	7.783	0.300	0.519	3.45
FSL201 R-10	8.928	0.817	11.308	0.000	1.072	0.000	2.040	6.889	0.335	0.482	2.59
FSL201 N-1	25.260	1.892	16.133	9.127	1.244	0.648	4.972	20.288	0.709	1.183	4.68
FSL201 N-2	40.024	2.849	70.838	0.000	3.552	0.000	7.253	32.771	0.733	2.116	10.07
FSL201 N-3	23.427	2.064	29.152	0.000	2.048	0.016	7.247	16.180	0.640	1.424	9.19
FSL201 N-4	33.788	2.590	22.362	11.426	1.825	0.765	6.559	27.229	0.612	1.978	6.11
FSL201 N-5	32.022	2.467	36.868	0.000	2.176	0.291	12.920	19.103	0.693	1.774	9.71
FSL201 N-6	14.306	1.287	17.731	0.000	1.298	0.000	8.349	5.957	0.736	0.551	4.90

Table A26. Elemental analysis of site IND105.											
	RAW		Water-Washed Soil				Cooked				LOI change in mass %
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	
IND105 R-1	52.658	2.661	53.937	0.000	2.770	0.000	29.804	22.854	0.759	1.901	9.48
IND105 R-2	45.444	2.143	47.551	0.000	2.289	0.000	28.401	17.043	0.493	1.650	6.23
IND105 R-3	61.744	2.843	70.686	0.000	3.467	0.000	33.432	28.312	0.591	2.252	8.45
IND105 R-4	51.523	2.499	52.769	0.000	2.561	0.000	23.446	28.078	0.618	1.880	8.17
IND105 R-5	74.949	3.719	64.831	10.118	3.372	0.346	37.557	37.392	0.766	2.953	9.67
IND105 R-6	67.175	2.633	71.868	0.000	2.804	0.000	43.391	23.784	0.671	1.962	7.87
IND105 R-7	68.637	2.400	75.047	0.000	2.612	0.000	49.513	19.124	0.621	1.779	7.76
IND105 R-8	54.231	2.105	59.486	0.000	2.121	0.000	43.377	10.854	0.554	1.552	6.48
IND105 R-9	41.902	2.910	46.050	0.000	2.975	0.000	12.502	29.401	0.846	2.064	9.39
IND105 R-10	75.303	3.473	75.947	0.000	3.493	0.000	42.147	33.156	0.785	2.688	10.04
IND105 N-1	69.676	3.511	58.934	10.741	3.112	0.399	38.958	30.717	0.790	2.721	12.04
IND105 N-2	75.030	3.932	69.002	6.028	3.702	0.231	42.674	32.356	1.075	2.858	13.57
IND105 N-3	83.080	3.036	89.048	0.000	3.492	0.000	58.452	24.627	0.612	2.424	10.01
IND105 N-4	77.386	3.212	87.535	0.000	3.963	0.000	51.502	25.885	0.947	2.265	10.78
IND105 N-5	63.819	2.732	66.006	0.000	2.975	0.000	42.803	21.016	0.744	1.988	9.07

Table A27. Elemental analysis of site IND123.											
	RAW		Water-Washed Soil				Cooked				LOI
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	change in mass %
IND123 R-1	39.331	1.720	47.876	0.000	1.950	0.000	29.988	9.343	0.432	1.288	5.28
IND123 R-2	63.525	3.736	43.652	19.873	2.427	1.309	18.964	44.561	0.530	3.206	6.37
IND123 R-3	28.552	2.151	25.034	3.518	1.878	0.273	8.926	19.626	0.534	1.617	3.82
IND123 R-4	10.354	0.811	10.178	0.176	0.669	0.143	4.252	6.103	0.205	0.606	1.07
IND123 R-5	18.731	1.382	26.587	0.000	1.907	0.000	4.730	14.000	0.265	1.116	2.24
IND123 R-6	27.379	1.562	26.221	1.157	1.559	0.003	10.497	16.882	0.409	1.153	3.10
IND123 R-7	10.716	0.636	14.442	0.000	0.853	0.000	6.541	4.175	0.289	0.346	1.37
IND123 R-8	39.542	2.866	37.839	1.703	2.527	0.339	14.367	25.175	0.730	2.136	7.36
IND123 R-9	18.502	1.383	16.817	1.685	1.291	0.092	5.608	12.894	0.313	1.069	3.78
IND123 R-10	38.180	2.136	30.655	7.525	1.792	0.343	16.235	21.945	0.496	1.640	0.00
IND123 N-1	70.095	4.362	70.585	0.000	4.490	0.000	25.562	44.533	0.967	3.395	8.45
IND123 N-2	41.018	2.677	39.908	1.109	2.741	0.000	12.801	28.216	0.573	2.105	4.54
IND123 N-3	44.178	3.545	46.476	0.000	3.552	0.000	36.607	7.571	0.077	3.468	5.45
IND123 N-4	166.062	12.318	127.868	38.194	9.449	2.869	47.522	118.540	2.905	9.413	16.11
IND123 N-5	135.716	8.805	84.358	51.358	5.555	3.250	29.614	106.103	1.271	7.534	15.39

Table A28. Elemental analysis of site IND131.											
	RAW		Water-Washed Soil				Cooked				LOI
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	change in mass %
IND131 R-1	97.046	3.443	96.265	0.781	3.073	0.370	70.753	26.293	0.723	2.720	6.85
IND131 R-2	79.479	2.745	76.345	3.134	2.428	0.317	62.340	17.139	0.679	2.066	5.67
IND131 R-3	66.818	2.749	59.479	7.338	2.342	0.407	45.053	21.765	0.461	2.288	6.01
IND131 R-4	77.850	5.195	69.473	8.376	4.073	1.122	29.611	48.238	1.106	4.089	9.37
IND131 R-5	98.469	3.376	98.070	0.400	3.117	0.259	76.365	22.105	0.691	2.685	6.57
IND131 R-6	27.843	2.369	31.070	0.000	2.680	0.000	5.529	22.314	0.886	1.482	5.98
IND131 R-7	40.702	3.950	38.335	2.368	3.358	0.592	5.965	34.737	0.992	2.958	6.77
IND131 R-8	35.499	4.968	36.337	0.000	4.565	0.403	7.073	28.426	1.488	3.480	6.78
IND131 R-9	37.444	3.986	37.507	0.000	3.534	0.452	4.980	32.463	1.011	2.976	7.33
IND131 R-10	60.961	5.285	58.203	2.758	4.489	0.796	7.559	53.402	1.255	4.030	10.20
IND131 N-1	100.141	5.116	85.421	14.720	4.367	0.749	45.581	54.560	1.059	4.057	9.27
IND131 N-2	76.261	3.438	73.587	2.674	3.351	0.086	48.127	28.134	0.973	2.465	9.43
IND131 N-3	77.655	3.874	69.565	8.090	3.492	0.382	47.977	29.679	0.968	2.905	8.81
IND131 N-4	82.837	4.792	79.169	3.667	4.494	0.299	48.382	34.454	1.458	3.334	11.79
IND131 N-5	120.342	9.357	161.503	0.000	11.679	0.000	30.332	90.010	2.842	6.516	29.43

Table A29. Elemental analysis of site LAW82.											
	RAW		Water-Washed Soil				Cooked				LOI
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	change in mass %
LAW082 R-1	5.784	0.454	6.134	0.000	0.334	0.120	4.795	0.988	0.186	0.268	1.61
LAW082 R-2	6.008	0.495	8.176	0.000	0.378	0.118	4.695	1.313	0.185	0.310	1.66
LAW082 R-3	10.098	0.971	8.578	1.521	0.584	0.387	4.660	5.439	0.278	0.693	2.17
LAW082 R-4	11.018	0.964	8.697	2.322	0.528	0.437	5.707	5.312	0.246	0.719	2.28
LAW082 R-5	11.771	1.206	12.103	0.000	0.818	0.388	3.746	8.025	0.258	0.949	2.65
LAW082 R-6	11.670	0.683	10.592	1.078	0.717	0.000	4.372	7.298	0.204	0.479	2.18
LAW082 R-7	8.905	0.464	12.422	0.000	0.538	0.000	9.649	0.000	0.241	0.224	1.62
LAW082 R-8	7.543	0.381	7.416	0.127	0.362	0.019	5.230	2.312	0.176	0.205	1.76
LAW082 R-9	4.184	0.235	4.044	0.141	0.216	0.019	3.157	1.028	0.153	0.082	1.25
LAW082 R-10	5.761	0.401	5.766	0.000	0.282	0.119	5.880	0.000	0.212	0.189	1.51
LAW082 N-1	6.559	0.467	5.935	0.624	0.410	0.058	2.550	4.009	0.200	0.267	1.89
LAW082 N-2	51.960	3.161	11.940	40.020	0.828	2.333	4.816	47.144	0.253	2.908	3.47
LAW082 N-3	22.415	1.342	18.808	3.607	0.750	0.591	5.287	17.128	0.241	1.101	2.76
LAW082 N-4	36.029	2.687	9.538	26.491	0.682	2.005	4.927	31.102	0.307	2.379	2.69
LAW082 N-5	17.055	1.116	12.057	4.998	0.824	0.293	4.559	12.496	0.278	0.838	2.57

Table A30. Elemental analysis of site LAW090.											
	RAW		Water-Washed Soil				Cooked				LOI
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	change in mass %
LAW090 R-1	29.400	1.391	20.123	9.278	1.318	0.073	10.701	18.699	0.470	0.922	3.90
LAW090 R-2	20.395	1.296	21.745	0.000	1.166	0.130	13.582	6.813	0.347	0.949	3.08
LAW090 R-3	32.607	1.419	27.760	4.847	2.058	0.000	14.292	18.315	0.602	0.817	4.05
LAW090 R-4	28.056	1.641	23.427	4.629	1.372	0.268	13.136	14.920	0.419	1.222	3.30
LAW090 R-5	26.818	1.277	19.785	7.033	1.308	0.000	12.643	14.174	0.440	0.836	3.66
LAW090 R-6	19.909	0.907	24.739	0.000	0.857	0.050	13.936	5.972	0.394	0.513	3.03
LAW090 R-7	21.786	0.969	18.930	2.856	0.967	0.002	14.163	7.622	0.341	0.628	3.07
LAW090 R-8	18.564	0.777	17.341	1.223	0.806	0.000	12.770	5.794	0.287	0.490	2.30
LAW090 R-9	24.789	0.621	14.056	10.733	0.683	0.000	11.999	12.790	0.286	0.335	2.46
LAW090 R-10	17.531	0.662	18.167	0.000	0.645	0.017	11.454	6.078	0.325	0.337	2.87
LAW090 N-1	13.891	0.523	16.656	0.000	0.506	0.018	12.667	1.223	0.263	0.260	2.79
LAW090 N-2	13.606	0.409	13.036	0.570	0.395	0.015	12.457	1.149	0.229	0.180	1.48
LAW090 N-3	17.336	0.476	13.036	4.300	0.395	0.081	11.098	6.238	0.214	0.262	1.82
LAW090 N-4	18.597	0.924	32.331	0.000	1.385	0.000	13.564	5.033	0.244	0.681	3.45
LAW090 N-5	14.459	0.423	15.167	0.000	0.467	0.000	15.429	0.000	0.226	0.196	1.80

Table A31. Elemental analysis of site LAW118.											
	RAW		Water-Washed Soil				Cooked				LOI
Sample Name	C conc. mgC/kg DW	N conc. mgN/kg DW	C conc. mgC/kg DW	leached C mgC/kg DW	N conc. mgN/kg DW	leached N mgN/kg DW	C conc. mgC/kg DW	Organic C mgC/kg DW	N conc. mgN/kg DW	Organic N mgN/kg DW	change in mass %
LAW118 R-1	12.626	0.599	13.106	0.000	0.667	0.000	8.511	4.115	0.257	0.342	1.81
LAW118 R-2	15.122	0.668	15.498	0.000	0.881	0.000	8.691	6.431	0.359	0.309	1.71
LAW118 R-3	13.501	0.707	9.883	3.619	0.680	0.027	7.859	5.642	0.293	0.414	1.94
LAW118 R-4	20.106	0.790	17.107	2.999	0.707	0.083	11.822	8.284	0.342	0.448	1.91
LAW118 R-5	12.092	0.602	12.625	0.000	0.682	0.000	9.347	2.745	0.437	0.165	1.89
LAW118 R-6	14.260	0.654	16.238	0.000	0.655	0.000	12.697	1.563	0.321	0.332	2.14
LAW118 R-7	17.518	0.944	15.198	2.321	0.767	0.177	10.744	6.774	0.384	0.559	2.70
LAW118 R-8	15.622	0.601	16.847	0.000	0.794	0.000	9.056	6.566	0.325	0.276	2.10
LAW118 R-9	15.595	0.885	12.799	2.796	0.617	0.268	10.535	5.060	0.328	0.557	2.19
LAW118 R-10	15.958	0.993	17.525	0.000	1.176	0.000	8.870	7.088	0.423	0.570	3.14
LAW118 N-1	32.753	2.009	25.878	6.875	1.533	0.476	20.446	12.307	1.214	0.795	7.56
LAW118 N-2	25.100	1.622	19.804	5.296	1.236	0.386	10.729	14.371	0.602	1.020	4.64
LAW118 N-3	22.085	1.426	18.384	3.701	1.256	0.170	9.913	12.171	0.659	0.767	4.49
LAW118 N-4	22.479	1.379	15.661	6.818	0.980	0.399	12.957	9.522	0.640	0.740	3.39
LAW118 N-5	26.675	2.056	14.352	12.323	1.215	0.841	8.125	18.550	0.536	1.520	4.02

Biomass of PLFAME

Table A32. Biomass of PLFAME for site BGP.	
Sample Name	Biomass-pm/g
BGP R-1	2521.67
BGP R-2	1772.37
BGP R-3	4671.31
BGP R-4	1969.80
BGP R-5	2941.97
BGP R-6	1220.35
BGP R-7	3834.31
BGP R-8	1977.01
BGP R-9	1395.28
BGP R-10	2319.54
BGP N-1	7267.91
BGP N-2	12573.78
BGP N-3	6465.93
BGP N-4	3521.15
BGP N-5	4532.58

Table A33. Biomass of PLFAME for site BIS097.	
Sample Name	Biomass-pm/g
BIS097 R-1	508.06
BIS097 R-2	439.18
BIS097 R-3	1260.54
BIS097 R-4	1323.43
BIS097 R-5	1210.45
BIS097 R-6	2778.50
BIS097 R-7	3080.29
BIS097 R-8	1630.05
BIS097 R-9	1088.37
BIS097 R-10	518.70
BIS097 N-1	7135.55
BIS097 N-2	1422.30
BIS097 N-3	3137.29
BIS097 N-4	8303.70
BIS097 N-5	430.26

Table A34. Biomass of PLFAME for site BLK016.	
Sample Name	Biomass-pm/g
BLK016 R-1	637.75
BLK016 R-2	206.70
BLK016 R-3	1144.49
BLK016 R-4	144.74
BLK016 R-5	323.21
BLK016 R-6	1957.84
BLK016 R-7	405.82
BLK016 R-8	749.36
BLK016 R-9	84.68
BLK016 R-10	100.96
BLK016 N-1	5219.99
BLK016 N-2	8981.17
BLK016 N-3	18014.06
BLK016 N-4	10525.18
BLK016 N-5	1505.87

Table A35. Biomass of PLFAME for site BIS097.	
Sample Name	Biomass-pm/g
FSL201 R-1	719.09
FSL201 R-2	306.66
FSL201 R-3	2148.94
FSL201 R-4	338.54
FSL201 R-5	407.38
FSL201 R-6	1792.88
FSL201 R-7	932.08
FSL201 R-8	542.03
FSL201 R-9	220.63
FSL201 R-10	227.96
FSL201 N-1	3034.70
FSL201 N-2	5451.91
FSL201 N-3	13514.81
FSL201 N-4	8065.50
FSL201 N-5	10776.06
FSL201 N-6	5220.59

Table A36. Biomass of PLFAME for site IND105.	
Sample Name	Biomass-pm/g
IND105 R-1	1298.75
IND105 R-2	318.63
IND105 R-3	689.56
IND105 R-4	245.57
IND105 R-5	800.17
IND105 R-6	280.98
IND105 R-7	156.55
IND105 R-8	260.71
IND105 R-9	640.84
IND105 R-10	210.03
IND105 N-1	7576.62
IND105 N-2	10455.37
IND105 N-3	4134.82
IND105 N-4	4453.56
IND105 N-5	6883.84

Table A37. Biomass of PLFAME for site IND123.	
Sample Name	Biomass-pm/g
IND123 R-1	106.20
IND123 R-2	253.94
IND123 R-3	915.18
IND123 R-4	83.88
IND123 R-5	692.10
IND123 R-6	294.79
IND123 R-7	144.99
IND123 R-8	7713.32
IND123 R-9	4269.08
IND123 R-10	1319.75
IND123 N-1	8138.83
IND123 N-2	5143.73
IND123 N-3	4059.87
IND123 N-4	7365.23
IND123 N-5	10749.05

Table A38. Biomass of PLFAME for site IND131.	
Sample Name	Biomass-pm/g
IND131 R-1	108.36
IND131 R-2	68.43
IND131 R-3	287.26
IND131 R-4	1105.45
IND131 R-5	65.04
IND131 R-6	249.36
IND131 R-7	741.13
IND131 R-8	1481.86
IND131 R-9	4383.76
IND131 R-10	2335.34
IND131 N-1	7245.26
IND131 N-2	21970.69
IND131 N-3	16054.56
IND131 N-4	8547.45
IND131 N-5	28026.92

Table A39. Biomass of PLFAME for site LAW082.	
Sample Name	Biomass-pm/g
LAW082 R-1	397.90
LAW082 R-2	323.24
LAW082 R-3	398.57
LAW082 R-4	422.13
LAW082 R-5	816.67
LAW082 R-6	319.01
LAW082 R-7	209.99
LAW082 R-8	310.92
LAW082 R-9	147.83
LAW082 R-10	75.70
LAW082 N-1	850.48
LAW082 N-2	2520.96
LAW082 N-3	2044.33
LAW082 N-4	4250.38
LAW082 N-5	2775.64

Table A40. Biomass of PLFAME for site LAW090.	
Sample Name	Biomass-pm/g
LAW090 R-1	1105.01
LAW090 R-2	1477.72
LAW090 R-3	997.18
LAW090 R-4	853.81
LAW090 R-5	1356.88
LAW090 R-6	584.65
LAW090 R-7	607.86
LAW090 R-8	931.29
LAW090 R-9	769.23
LAW090 R-10	1447.43
LAW090 N-1	2509.28
LAW090 N-2	660.58
LAW090 N-3	1003.69
LAW090 N-4	4377.97
LAW090 N-5	590.69

Table A41. Biomass of PLFAME for site LAW118.	
Sample Name	Biomass-pm/g
LAW118 R-1	750.02
LAW118 R-2	528.02
LAW118 R-3	394.10
LAW118 R-4	297.11
LAW118 R-5	304.18
LAW118 R-6	483.50
LAW118 R-7	1960.30
LAW118 R-8	856.68
LAW118 R-9	660.90
LAW118 R-10	764.22
LAW118 N-1	19248.64
LAW118 N-2	9092.47
LAW118 N-3	8603.33
LAW118 N-4	4731.23
LAW118 N-5	4794.63

Total sterols

Table A42. Total sterols for site BGP.	
Sample Name	pmol/g
BGP R-1	6346.89
BGP R-2	5134.46
BGP R-3	12349.74
BGP R-4	6241.20
BGP R-5	6533.18
BGP R-6	4948.66
BGP R-7	7968.72
BGP R-8	4552.85
BGP R-9	3956.02
BGP R-10	4808.02
BGP N-1	11269.57
BGP N-2	3124.08
BGP N-3	11112.07
BGP N-4	1975.32
BGP N-5	2862.59

Table A43. Total sterols for site BIS097.	
Sample Name	pmol/g
BIS097 R-1	3995.99
BIS097 R-2	5124.20
BIS097 R-3	9557.94
BIS097 R-4	6343.71
BIS097 R-5	9294.38
BIS097 R-6	8570.16
BIS097 R-7	7429.68
BIS097 R-8	14020.29
BIS097 R-9	12825.05
BIS097 R-10	7477.11
BIS097 N-1	9889.02
BIS097 N-2	4960.45
BIS097 N-3	35279.96
BIS097 N-4	17658.59
BIS097 N-5	4631.20

Table A44. Total sterols for site BLK016.	
Sample Name	pmol/g
BLK016 R-1	4833.86
BLK016 R-2	3146.61
BLK016 R-3	6967.21
BLK016 R-4	2723.06
BLK016 R-5	4364.23
BLK016 R-6	7713.54
BLK016 R-7	839.72
BLK016 R-8	2222.61
BLK016 R-9	1026.81
BLK016 R-10	673.16
BLK016 N-1	17151.77
BLK016 N-2	29045.77
BLK016 N-3	67835.09
BLK016 N-4	53904.10
BLK016 N-5	12494.39

Table A45. Total sterols for site FSL201.	
Sample Name	pmol/g
FSL201 R-1	2000.71
FSL201 R-2	3863.60
FSL201 R-3	7130.48
FSL201 R-4	2101.28
FSL201 R-5	1832.87
FSL201 R-6	5958.79
FSL201 R-7	4498.10
FSL201 R-8	720.23
FSL201 R-9	725.47
FSL201 R-10	641.27
FSL201 N-1	7320.20
FSL201 N-2	16117.66
FSL201 N-3	43632.17
FSL201 N-4	26329.72
FSL201 N-5	14086.80
FSL201 N-6	11967.13

Table A46. Total sterols for site IND105.	
Sample Name	pmol/g
IND105 R-1	3207.38
IND105 R-2	2952.31
IND105 R-3	5785.19
IND105 R-4	2549.33
IND105 R-5	6570.91
IND105 R-6	3850.36
IND105 R-7	1428.08
IND105 R-8	1533.06
IND105 R-9	2708.99
IND105 R-10	1062.58
IND105 N-1	11311.23
IND105 N-2	18997.51
IND105 N-3	11409.14
IND105 N-4	11229.84
IND105 N-5	8029.10

Table A47. Total sterols for site IND123.	
Sample Name	pmol/g
IND123 R-1	5684.04
IND123 R-2	3251.65
IND123 R-3	3535.16
IND123 R-4	1026.12
IND123 R-5	7111.40
IND123 R-6	1547.61
IND123 R-7	1436.94
IND123 R-8	19399.04
IND123 R-9	10180.83
IND123 R-10	3376.75
IND123 N-1	23870.59
IND123 N-2	18025.14
IND123 N-3	8633.08
IND123 N-4	43424.15
IND123 N-5	33964.09

Table A48. Total sterols for site IND131.	
Sample Name	pmol/g
IND131 R-1	2688.61
IND131 R-2	3854.73
IND131 R-3	3793.21
IND131 R-4	6924.02
IND131 R-5	2453.60
IND131 R-6	841.35
IND131 R-7	2405.37
IND131 R-8	1252.01
IND131 R-9	4305.59
IND131 R-10	3036.05
IND131 N-1	27362.49
IND131 N-2	30564.89
IND131 N-3	31408.24
IND131 N-4	21105.82
IND131 N-5	66399.32

Table A49. Total sterols for site LAW082.	
Sample Name	pmol/g
LAW082 R-1	204.05
LAW082 R-2	166.99
LAW082 R-3	633.54
LAW082 R-4	492.44
LAW082 R-5	922.10
LAW082 R-6	773.96
LAW082 R-7	269.48
LAW082 R-8	0.00
LAW082 R-9	156.69
LAW082 R-10	0.00
LAW082 N-1	949.46
LAW082 N-2	10911.44
LAW082 N-3	6130.45
LAW082 N-4	11127.24
LAW082 N-5	1772.00

Table A50. Total sterols for site LAW090.	
Sample Name	pmol/g
LAW090 R-1	2909.04
LAW090 R-2	1471.69
LAW090 R-3	1321.51
LAW090 R-4	922.02
LAW090 R-5	803.83
LAW090 R-6	720.46
LAW090 R-7	1103.25
LAW090 R-8	819.61
LAW090 R-9	1862.42
LAW090 R-10	1232.57
LAW090 N-1	2713.61
LAW090 N-2	397.46
LAW090 N-3	580.82
LAW090 N-4	3424.47
LAW090 N-5	286.01

Table A51. Total sterols for site LAW118.	
Sample Name	pmol/g
LAW118 R-1	2831.93
LAW118 R-2	1028.91
LAW118 R-3	399.71
LAW118 R-4	565.96
LAW118 R-5	419.40
LAW118 R-6	431.07
LAW118 R-7	7851.99
LAW118 R-8	778.22
LAW118 R-9	1634.50
LAW118 R-10	2407.99
LAW118 N-1	34033.35
LAW118 N-2	32595.84
LAW118 N-3	21734.46
LAW118 N-4	10724.98
LAW118 N-5	8689.40

Isotopes

Table A52. Isotopes for site BGP.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
BGP R-1	-23.759	5.531	0.000	50.121	-24.456	4.940
BGP R-2	-23.182	7.445	-22.675	8.400	-23.364	7.855
BGP R-3	-23.790	8.110	-32.938	13.065	-24.405	8.170
BGP R-4	-22.981	6.489	0.000	0.000	-23.768	6.001
BGP R-5	-21.206	8.367	-20.016	9.473	-21.459	8.583
BGP R-6	-22.678	6.565	-22.979	7.678	-23.121	7.101
BGP R-7	-22.409	8.371	-22.819	8.903	-22.920	8.409
BGP R-8	-23.818	7.522	0.000	0.000	-24.156	7.796
BGP R-9	-22.260	6.750	0.000	0.000	-22.605	6.387
BGP R-10	-22.753	6.887	-39.928	10.083	-23.057	7.002
BGP N-1	-22.736	6.052	0.000	0.000	-24.534	5.821
BGP N-2	-24.085	5.125	-26.043	3.017	-25.024	3.165
BGP N-3	-23.755	6.402	0.000	0.000	-24.400	6.488
BGP N-4	-23.175	7.562	-29.610	21.853	-24.799	7.360
BGP N-5	-24.543	4.353	-29.805	8.438	-25.831	1.316

Table A53. Isotopes for site BIS097.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
BIS097 R-1	-22.310	6.741	0.000	12.556	-22.408	8.225
BIS097 R-2	-23.403	4.740	-25.587	2.606	-23.557	5.315
BIS097 R-3	-23.849	4.465	0.000	1.958	-24.119	4.593
BIS097 R-4	-22.984	4.613	0.000	0.000	-23.263	4.666
BIS097 R-5	-22.581	5.822	-22.786	7.384	-22.893	5.752
BIS097 R-6	-22.837	6.219	0.000	10.946	-23.084	5.769
BIS097 R-7	-22.839	5.162	0.000	5.024	-23.047	4.630
BIS097 R-8	-22.818	5.120	0.000	-6.116	-22.996	4.932
BIS097 R-9	-22.609	5.766	0.000	0.000	-22.789	5.586
BIS097 R-10	-21.244	4.036	0.000	0.000	-21.374	4.830
BIS097 N-1	-22.278	4.817	-17.611	-13.519	-22.613	4.363
BIS097 N-2	-21.631	5.208	0.000	0.000	-21.793	6.336
BIS097 N-3	-18.233	6.096	-18.233	6.096	-18.493	6.292
BIS097 N-4	-17.297	6.482	27.351	1.674	-17.412	6.922
BIS097 N-5	-20.982	3.518	17.624	-6.400	-21.226	3.902

Table A54. Isotopes for site BLK016.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
BLK016 R-1	-9.701	6.092	-47.082	-5.761	-26.671	6.243
BLK016 R-2	-6.379	3.798	0.000	0.000	-39.906	3.718
BLK016 R-3	-7.984	6.808	-15.859	0.914	-22.789	7.137
BLK016 R-4	-5.660	6.248	-25.741	-35.562	-24.467	6.527
BLK016 R-5	-7.356	6.530	-109.903	-47.266	-25.867	6.515
BLK016 R-6	-8.459	5.182	0.000	0.000	-24.949	5.170
BLK016 R-7	-9.710	3.222	-12.670	-4.241	-24.242	3.113
BLK016 R-8	-9.473	5.234	-213.679	-12.792	-24.161	4.797
BLK016 R-9	-6.329	4.454	0.000	0.000	0.000	4.521
BLK016 R-10	-6.370	5.458	-17.483	1.436	-21.481	5.713
BLK016 N-1	-11.555	6.080	-26.224	0.000	-20.887	5.278
BLK016 N-2	-21.605	5.407	0.000	0.000	-23.926	4.964
BLK016 N-3	-19.703	5.264	-87.348	-1.667	-22.084	4.803
BLK016 N-4	-13.707	7.275	-14.032	9.474	-19.752	6.976
BLK016 N-5	-11.343	9.625	0.000	0.000	-24.648	9.916

Table A55. Isotopes for site FSL201.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
FSL201 R-1	-16.749	6.558	-13.310	2.730	-23.341	7.303
FSL201 R-2	-18.279	6.313	0.000	-11.553	-22.258	8.085
FSL201 R-3	-20.204	6.058	-34.542	-7.603	-22.367	6.906
FSL201 R-4	-22.051	5.454	-25.047	5.212	-23.819	5.614
FSL201 R-5	-20.547	6.177	0.000	0.000	-23.591	7.680
FSL201 R-6	-21.093	7.094	0.000	0.000	-23.031	7.722
FSL201 R-7	-19.937	7.539	-15.557	8.570	-20.046	7.819
FSL201 R-8	-22.078	4.620	0.000	0.000	-23.576	4.702
FSL201 R-9	-22.737	3.471	0.000	0.000	-24.278	4.098
FSL201 R-10	-22.345	3.059	0.000	0.000	-23.710	1.851
FSL201 N-1	-23.308	5.605	-24.588	9.360	-26.661	3.760
FSL201 N-2	-22.711	4.250	0.000	0.000	-24.130	3.026
FSL201 N-3	-17.572	8.133	0.000	-60.529	-21.399	7.020
FSL201 N-4	-16.601	8.849	-17.188	6.787	-18.043	8.796
FSL201 N-5	-16.188	7.981	0.000	20.964	-21.212	7.790
FSL201 N-6	-17.082	9.577	0.000	0.000	-28.535	7.862

Table A56. Isotopes for site IND105.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
IND105 R-1	-14.006	8.971	0.000	0.000	-24.196	8.572
IND105 R-2	-11.711	8.075	0.000	0.000	-21.920	8.434
IND105 R-3	-13.651	8.432	0.000	0.000	-22.403	8.533
IND105 R-4	-15.589	6.574	0.000	0.000	-21.738	6.160
IND105 R-5	-13.722	8.840	-15.048	-5.177	-20.882	8.565
IND105 R-6	-13.183	7.257	0.000	0.000	-25.277	7.278
IND105 R-7	-13.795	6.096	0.000	0.000	-28.618	5.874
IND105 R-8	-15.214	5.912	0.000	0.000	-41.287	5.990
IND105 R-9	-21.312	5.671	0.000	0.000	-25.519	4.584
IND105 R-10	-17.342	5.938	0.000	0.000	-28.212	5.626
IND105 N-1	-12.470	8.754	-17.990	-37.056	-21.017	8.532
IND105 N-2	-12.307	9.177	-17.332	-17.782	-20.793	8.735
IND105 N-3	-10.164	9.564	0.000	0.000	-22.767	9.762
IND105 N-4	-10.199	10.645	0.000	0.000	-22.147	10.482
IND105 N-5	-9.131	12.246	0.000	0.000	-20.819	12.619

Table A57. Isotopes for site IND123.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
IND123 R-1	-15.153	4.741	0.000	0.000	-37.298	4.487
IND123 R-2	-19.516	5.865	-22.306	3.605	-23.544	5.913
IND123 R-3	-18.218	6.650	-20.175	-13.315	-21.566	6.729
IND123 R-4	-16.647	1.992	-35.150	-23.094	-22.580	1.934
IND123 R-5	-17.624	9.202	0.000	0.000	-20.253	10.198
IND123 R-6	-16.357	5.184	-14.160	-880.369	-20.974	4.969
IND123 R-7	-14.850	3.361	0.000	0.000	-26.078	3.564
IND123 R-8	-12.262	11.752	-41.930	1.435	-16.890	11.674
IND123 R-9	-14.140	9.612	-31.534	-13.118	-17.781	10.279
IND123 R-10	-14.873	7.381	-18.107	0.706	-19.802	7.592
IND123 N-1	-15.247	10.382	0.000	0.000	-19.188	9.732
IND123 N-2	-16.519	11.451	-32.311	0.000	-20.094	11.532
IND123 N-3	-18.773	11.784	0.000	0.000	-56.970	11.694
IND123 N-4	-19.333	11.334	-19.186	7.908	-23.465	10.846
IND123 N-5	-18.990	10.936	-22.385	5.950	-21.931	10.508

Table A58. Isotopes for site IND131.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
IND131 R-1	-9.543	7.304	-111.507	5.749	-21.036	7.402
IND131 R-2	-6.020	8.631	9.109	18.873	-14.782	9.892
IND131 R-3	-8.314	7.200	-10.211	-4.634	-17.397	8.171
IND131 R-4	-16.697	6.505	-19.658	0.272	-22.095	6.378
IND131 R-5	-12.029	6.401	-136.241	-20.697	-25.862	6.643
IND131 R-6	-23.260	4.962	0.000	0.000	-23.755	5.156
IND131 R-7	-22.626	4.872	-19.032	0.049	-23.224	5.055
IND131 R-8	-24.018	5.122	0.000	-4.963	-24.168	4.750
IND131 R-9	-23.729	3.054	0.000	-3.107	-23.829	2.930
IND131 R-10	-24.423	3.251	-27.145	-2.862	-24.699	2.624
IND131 N-1	-12.312	8.870	-15.150	0.240	-17.604	8.519
IND131 N-2	-10.336	10.099	-11.244	-118.536	-19.572	10.559
IND131 N-3	-11.145	10.089	-18.411	-28.534	-21.607	9.995
IND131 N-4	-12.100	10.566	-29.133	-21.815	-21.128	10.156
IND131 N-5	-19.458	7.739	0.000	0.000	-21.330	6.488

Table A59. Isotopes for site LAW082.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
LAW082 R-1	-7.835	3.610	0.000	1.954	-33.790	3.099
LAW082 R-2	-7.848	4.324	0.000	13.597	-32.119	5.482
LAW082 R-3	-14.778	4.856	-23.978	8.394	-22.906	5.796
LAW082 R-4	-12.119	6.752	-11.658	10.610	-19.472	8.579
LAW082 R-5	-13.546	6.706	0.000	11.417	-17.274	7.890
LAW082 R-6	-11.034	3.443	-11.270	0.000	-15.492	3.964
LAW082 R-7	-6.824	5.433	0.000	0.000	0.000	10.059
LAW082 R-8	-5.865	6.025	5.635	-81.659	-16.728	-2.580
LAW082 R-9	-7.867	4.803	5.624	-63.498	-24.021	-20.810
LAW082 R-10	-9.547	4.366	0.000	9.038	0.000	7.147
LAW082 N-1	-16.304	1.602	-38.469	-26.159	-21.341	1.813
LAW082 N-2	-23.490	7.147	-26.050	7.015	-25.281	7.526
LAW082 N-3	-18.172	6.451	-49.018	7.434	-22.514	7.374
LAW082 N-4	-22.462	3.873	-25.523	2.662	-24.923	3.963
LAW082 N-5	-18.783	3.282	-29.508	-1.549	-23.355	3.171

Table A60. Isotopes for site LAW090.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
LAW090 R-1	-9.481	3.125	-7.752	-31.750	-13.661	2.437
LAW090 R-2	-12.376	3.044	0.000	-7.055	-35.106	2.582
LAW090 R-3	-9.271	3.447	15.966	0.000	-14.333	2.388
LAW090 R-4	-12.020	2.310	-22.936	-9.399	-20.999	2.617
LAW090 R-5	-9.363	2.163	-8.241	0.000	-15.178	0.849
LAW090 R-6	-8.280	3.785	0.000	-39.039	-23.819	4.862
LAW090 R-7	-8.468	2.337	-12.259	-1435.120	-22.190	1.923
LAW090 R-8	-7.832	1.904	-35.357	0.000	-22.362	1.655
LAW090 R-9	-5.325	1.705	-3.541	0.000	-9.342	2.728
LAW090 R-10	-7.061	5.078	0.000	18.196	-15.997	7.861
LAW090 N-1	-5.398	5.393	0.000	-98.154	-53.002	8.317
LAW090 N-2	-4.763	3.751	-38.002	-13.939	-48.219	4.726
LAW090 N-3	-3.771	4.941	-5.169	7.500	-9.808	6.227
LAW090 N-4	-9.275	8.376	0.000	0.000	-31.822	10.199
LAW090 N-5	-3.423	3.510	0.000	0.000	0.000	4.293

Table A61. Isotopes for site IND118.						
	Total		Leached		Organic	
Sample Name	d13C ‰	d15N ‰	d13C ‰	d15N ‰	d13C ‰	d15N ‰
LAW118 R-1	-8.578	5.066	0.000	0.000	-21.920	-3.511
LAW118 R-2	-7.624	4.750	0.000	0.000	-14.932	-18.496
LAW118 R-3	-8.868	4.501	-8.589	-285.292	-18.027	-10.453
LAW118 R-4	-8.531	6.895	-16.523	-26.368	-17.251	-1.609
LAW118 R-5	-8.126	2.213	0.000	0.000	-25.568	3.049
LAW118 R-6	-8.003	4.980	0.000	0.000	-64.036	-2.192
LAW118 R-7	-9.638	2.031	-11.950	-8.421	-19.748	0.919
LAW118 R-8	-6.323	3.612	0.000	0.000	-11.973	1.750
LAW118 R-9	-11.126	3.248	-27.793	1.664	-30.167	3.228
LAW118 R-10	-12.866	2.909	0.000	0.000	-24.372	1.713
LAW118 N-1	-14.990	6.183	-23.448	0.477	-22.433	2.937
LAW118 N-2	-17.658	7.094	-36.977	1.169	-26.502	7.123
LAW118 N-3	-15.856	6.159	-29.110	-6.617	-22.991	4.805
LAW118 N-4	-14.995	4.588	-25.031	-0.206	-28.878	2.862
LAW118 N-5	-18.023	4.463	-21.493	2.037	-23.480	4.403

P Value Tables

The P values in the following tables were calculated via Analysis of Variance (ANOVA) tools in Microsoft Excel. The P values result from comparisons of the calculated F statistics to tabled critical F values in F tests. An F test uses the F statistic to test any one of several kinds of statistical hypotheses about the distributions of a sample or samples. The t test is one specialized form of the F test, and a general ANOVA is often referred to as an F test.

For these F tests we report the P-value of comparisons between each of 20 pairs of means, the means of each of two kinds of sites (revegetated R and native N) at all the locations. There are ten locations and usually ten Rs and five Ns for each location, but the numbers of Rs and Ns can vary somewhat. For each location the test is for similarity of sample means, and the null hypothesis is that any observed difference in means is due to random chance. If the null hypothesis were true, then the probability that the P value obeys $P < \alpha$ is α, and the probability that $P \geq \alpha$ is $1 - \alpha$. The null hypothesis is said to be rejected at the α level if $P < \alpha$. If the test level α is taken to be 0.05, then when $P \geq 0.05$ for our hypothesis for any one pairwise comparison (i.e. one location separately from the rest of the locations), we can say that the means are not significantly different at the $\alpha = 0.05$ level.

In the following tables the P values that are less than 0.05 are highlighted in green. For these P values the means of corresponding pairs of samples are significantly different at the $\alpha = 0.05$ level, while for the unhighlighted P values the means of corresponding pairs of samples are not significantly different at the $\alpha = 0.05$ level. For instance, from the Sand P value table, reading down the first column BGP R is not significantly different from BGP N but is significantly different from BIS097 N.

Table A62. P values for % sand.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.1232																		
BIS097 R	0.1623	0.9499																	
BIS097 N	0.0006	0.0013	0.0495																
BLK016 R	0.0000	0.0000	0.0000	0.0000															
BLK016 N	0.0002	0.0006	0.0001	0.0001	0.8106														
FSL201 R	0.2228	0.0550	0.0334	0.0013	0.0002	0.0026													
FSL201 N	0.0788	0.0214	0.0177	0.0007	0.0044	0.0241	0.5712												
IND105 R	0.0000	0.0000	0.0000	0.0000	0.0037	0.0505	0.0000	0.0000											
1ND105 N	0.0000	0.0000	0.0000	0.0000	0.7049	0.6466	0.0027	0.0160	0.0094										
IND123 R	0.0136	0.0233	0.0038	0.0038	0.3192	0.3946	0.0705	0.2479	0.0038	0.5914									
IND123 N	0.0003	0.0001	0.0002	0.0000	0.1444	0.2265	0.0246	0.1020	0.0013	0.2625	0.9216								
IND131 R	0.0000	0.0000	0.0000	0.0000	0.0002	0.0067	0.0000	0.0000	0.2418	0.0006	0.0004	0.0001							
IND131 N	0.0001	0.0004	0.0000	0.0001	0.3810	0.6552	0.0013	0.0105	0.1752	0.3379	0.2126	0.1016	0.0343						
LAW082 R	0.2247	0.0121	0.0209	0.0000	0.0000	0.0004	0.7442	0.3112	0.0000	0.0000	0.0390	0.0011	0.0000	0.0001					
LAW082 N	0.2628	0.5080	0.7527	0.0001	0.0000	0.0009	0.1036	0.0380	0.0000	0.0000	0.0362	0.0001	0.0000	0.0005	0.0361				
LAW090 R	0.1184	0.0004	0.0079	0.0000	0.0000	0.0002	0.7735	0.2720	0.0000	0.0000	0.0373	0.0002	0.0000	0.0001	0.9148	0.0016			
LAW090 N	0.2184	0.6952	0.8529	0.0010	0.0000	0.0008	0.0901	0.0347	0.0000	0.0000	0.0334	0.0001	0.0000	0.0005	0.0308	0.8361	0.0026		
LAW118 R	0.0104	0.0074	0.0017	0.0003	0.0171	0.0550	0.1373	0.4379	0.0000	0.0851	0.4343	0.4168	0.0000	0.0176	0.0534	0.0125	0.0454	0.0110	
LAW118 N	0.0005	0.0001	0.0003	0.0000	0.0874	0.1644	0.0395	0.1485	0.0008	0.1596	0.8050	0.7686	0.0001	0.0719	0.0032	0.0001	0.0005	0.0001	0.5581

Table A63. P values for % silt.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.9022																		
BIS097 R	0.1925	0.3320																	
BIS097 N	0.0081	0.0013	0.3199																
BLK016 R	0.0000	0.0000	0.0000	0.0000															
BLK016 N	0.0001	0.0011	0.0000	0.0002	0.4194														
FSL201 R	0.3766	0.4588	0.0884	0.0320	0.0000	0.0004													
FSL201 N	0.0950	0.1616	0.0290	0.0082	0.0002	0.0072	0.5061												
IND105 R	0.0000	0.0001	0.0000	0.0000	0.8670	0.5523	0.0000	0.0008											
1ND105 N	0.0001	0.0003	0.0001	0.0000	0.0171	0.1822	0.0052	0.0315	0.0510										
IND123 R	0.0751	0.1880	0.0294	0.0520	0.0041	0.0942	0.1954	0.4935	0.0093	0.4879									
IND123 N	0.0062	0.0316	0.0030	0.0048	0.0197	0.1896	0.0462	0.1844	0.0473	0.7718	0.6768								
IND131 R	0.0000	0.0000	0.0000	0.0000	0.0026	0.0017	0.0000	0.0000	0.0043	0.0000	0.0000	0.0000							
IND131 N	0.0003	0.0040	0.0002	0.0009	0.4544	1.0000	0.0020	0.0168	0.5784	0.2461	0.1153	0.2344	0.0051						
LAW082 R	0.4895	0.4581	0.0699	0.0012	0.0000	0.0000	0.6552	0.1890	0.0000	0.0000	0.1134	0.0084	0.0000	0.0002					
LAW082 N	0.6936	0.7205	0.4130	0.0000	0.0000	0.0008	0.3773	0.1188	0.0003	0.0001	0.1732	0.0250	0.0000	0.0033	0.2967				
LAW090 R	0.0061	0.0057	0.0011	0.0000	0.0000	0.0002	0.3589	0.9293	0.0000	0.0004	0.3321	0.0445	0.0000	0.0008	0.0310	0.0013			
LAW090 N	0.7151	0.7814	0.4307	0.0033	0.0000	0.0010	0.3876	0.1318	0.0003	0.0002	0.1751	0.0272	0.0000	0.0035	0.3332	1.0000	0.0045		
LAW118 R	0.0048	0.0246	0.0011	0.0011	0.0001	0.0114	0.0657	0.3178	0.0008	0.1711	0.9035	0.4391	0.0000	0.0208	0.0118	0.0175	0.1255	0.0192	
LAW118 N	0.0001	0.0008	0.0001	0.0000	0.0279	0.2475	0.0049	0.0313	0.0723	0.8462	0.4278	0.6797	0.0000	0.3104	0.0002	0.0005	0.0012	0.0006	0.1412

Table A64. P values for % clay.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0129																		
BIS097 R	0.2723	0.1055																	
BIS097 N	0.0010	0.1451	0.0099																
BLK016 R	0.0017	0.7516	0.0299	0.2394															
BLK016 N	0.4016	0.0497	0.1554	0.0133	0.0103														
FSL201 R	0.2497	0.0081	0.0528	0.0009	0.0007	1.0000													
FSL201 N	0.2629	0.0158	0.0770	0.0031	0.0024	0.9309	0.9031												
IND105 R	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0001											
IND105 N	0.0003	0.0000	0.0001	0.0000	0.0000	0.0953	0.0268	0.0615	0.0047										
IND123 R	0.0021	0.0005	0.0005	0.0001	0.0000	0.1109	0.0296	0.0889	0.0232	0.9387									
IND123 N	0.1880	0.0272	0.0670	0.0077	0.0043	0.7453	0.6451	0.7700	0.0017	0.2238	0.2335								
IND131 R	0.0692	0.0055	0.0149	0.0009	0.0003	0.5741	0.4326	0.5939	0.0002	0.1870	0.1575	0.8904							
IND131 N	0.0220	0.0051	0.0073	0.0016	0.0005	0.3018	0.1492	0.2675	0.0248	0.7913	0.7527	0.4775	0.4260						
LAW082 R	0.1692	0.0011	0.0235	0.0001	0.0001	1.0000	1.0000	0.8869	0.0000	0.0050	0.0191	0.5985	0.3874	0.1012					
LAW082 N	0.1180	0.1662	0.5765	0.0130	0.1263	0.1451	0.0519	0.0662	0.0000	0.0000	0.0031	0.0788	0.0283	0.0149	0.0147				
LAW090 R	0.3213	0.0058	0.7028	0.0001	0.0026	0.1431	0.0524	0.0603	0.0000	0.0000	0.0003	0.0522	0.0141	0.0033	0.0159	0.1889			
LAW090 N	0.0639	0.2589	0.3966	0.0184	0.2037	0.1078	0.0332	0.0442	0.0000	0.0000	0.0022	0.0580	0.0194	0.0107	0.0076	0.6893	0.0768		
LAW118 R	0.1330	0.0043	0.0250	0.0005	0.0003	0.8123	0.7412	0.8796	0.0000	0.0455	0.0533	0.8176	0.6238	0.2127	0.7082	0.0260	0.0224	0.0157	
LAW118 N	0.6496	0.0073	0.5692	0.0007	0.0096	0.3646	0.2185	0.2270	0.0000	0.0000	0.0105	0.2058	0.1003	0.0418	0.1113	0.1248	0.6403	0.0421	0.1338

Table A65. P values for total carbon.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0968																		
BIS097 R	0.0003	0.0315																	
BIS097 N	0.0023	0.0156	0.2228																
BLK016 R	0.0000	0.0000	0.0000	0.0000															
BLK016 N	0.0000	0.0000	0.0000	0.0000	0.0300														
FSL201 R	0.0061	0.4921	0.0654	0.0179	0.0000	0.0000													
FSL201 N	0.5131	0.0251	0.0001	0.0002	0.0000	0.0000	0.0011												
IND105 R	0.0000	0.0000	0.0000	0.0000	0.4885	0.0343	0.0000	0.0000											
1ND105 N	0.0000	0.0000	0.0000	0.0000	0.0157	0.9540	0.0000	0.0000	0.0277										
IND123 R	0.4495	0.0993	0.0018	0.0097	0.0000	0.0000	0.0103	0.8561	0.0002	0.0000									
IND123 N	0.0021	0.0103	0.0003	0.0053	0.1209	0.4955	0.0005	0.0162	0.0966	0.5005	0.0051								
IND131 R	0.0004	0.0011	0.0000	0.0002	0.9724	0.3672	0.0000	0.0063	0.7555	0.3479	0.0032	0.1773							
IND131 N	0.0000	0.0000	0.0000	0.0000	0.0007	0.0780	0.0000	0.0000	0.0011	0.0703	0.0000	0.9990	0.0429						
LAW082 R	0.0001	0.0026	0.1747	0.8647	0.0000	0.0000	0.0041	0.0000	0.0000	0.0000	0.0007	0.0001	0.0000	0.0000					
LAW082 N	0.7819	0.2251	0.0108	0.0331	0.0001	0.0001	0.0466	0.8731	0.0008	0.0001	0.7743	0.0285	0.0164	0.0001	0.0046				
LAW090 R	0.8106	0.0177	0.0000	0.0000	0.0000	0.0000	0.0003	0.2505	0.0000	0.0000	0.3218	0.0010	0.0002	0.0000	0.0000	0.6348			
LAW090 N	0.0598	0.8390	0.0113	0.0001	0.0000	0.0000	0.5482	0.0096	0.0000	0.0000	0.0835	0.0096	0.0015	0.0000	0.0002	0.1795	0.0038		
LAW118 R	0.0072	0.6677	0.0021	0.0000	0.0000	0.0000	0.5291	0.0003	0.0000	0.0000	0.0132	0.0003	0.0000	0.0000	0.0000	0.0476	0.0001	0.7944	
LAW118 N	0.8359	0.0132	0.0000	0.0000	0.0000	0.0000	0.0005	0.6098	0.0000	0.0000	0.6349	0.0214	0.0085	0.0000	0.0000	0.9051	0.5035	0.0003	0.0000

Table A66. P values for total nitrogen.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0485																		
BIS097 R	0.0020	0.4397																	
BIS097 N	0.0024	0.0346	0.1469																
BLK016 R	0.2167	0.0578	0.0027	0.0001															
BLK016 N	0.0006	0.0001	0.0000	0.0000	0.0000														
FSL201 R	0.0005	0.1444	0.5300	0.1914	0.0002	0.0000													
FSL201 N	0.5161	0.0602	0.0054	0.0004	0.6128	0.0003	0.0005												
IND105 R	0.4044	0.0004	0.0000	0.0000	0.0063	0.0001	0.0000	0.0644											
IND105 N	0.0740	0.0000	0.0000	0.0000	0.0003	0.0186	0.0000	0.0037	0.0689										
IND123 R	0.1422	0.5034	0.1337	0.0529	0.5147	0.0000	0.0543	0.4153	0.0156	0.0044									
IND123 N	0.0101	0.0206	0.0014	0.0107	0.0043	0.4930	0.0011	0.0263	0.0129	0.1191	0.0041								
IND131 R	0.0062	0.0003	0.0000	0.0000	0.0001	0.0789	0.0000	0.0029	0.0102	0.3131	0.0003	0.0727							
IND131 N	0.0037	0.0035	0.0001	0.0010	0.0007	0.7898	0.0001	0.0068	0.0042	0.0797	0.0009	0.6346	0.1029						
LAW082 R	0.0000	0.0004	0.0016	0.0622	0.0000	0.0000	0.0014	0.0000	0.0000	0.0000	0.0010	0.0002	0.0000	0.0000					
LAW082 N	0.2029	0.6900	0.3016	0.1394	0.4646	0.0011	0.1585	0.4161	0.0337	0.0139	0.8804	0.0299	0.0038	0.0087	0.0089				
LAW090 R	0.0002	0.0657	0.2744	0.4108	0.0001	0.0000	0.5644	0.0001	0.0000	0.0000	0.0297	0.0005	0.0000	0.0000	0.0056	0.0980			
LAW090 N	0.0004	0.0013	0.0061	0.0155	0.0000	0.0000	0.0027	0.0000	0.0000	0.0000	0.0098	0.0069	0.0000	0.0005	0.6469	0.0342	0.0074		
LAW118 R	0.0000	0.0002	0.0026	0.0567	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	0.0017	0.0002	0.0000	0.0000	0.2977	0.0093	0.0093	0.0538	
LAW118 N	0.0870	0.5367	0.1418	0.0009	0.1458	0.0001	0.0179	0.1058	0.0013	0.0000	0.7534	0.0240	0.0008	0.0043	0.0000	0.9162	0.0064	0.0000	0.0000

Table A67. P values for organic carbon.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0622																		
BIS097 R	0.0006	0.1148																	
BIS097 N	0.0032	0.0310	0.1585																
BLK016 R	0.0490	0.6665	0.0442	0.0269															
BLK016 N	0.0028	0.0010	0.0000	0.0002	0.0001														
FSL201 R	0.0012	0.2350	0.6839	0.1204	0.0877	0.0000													
FSL201 N	0.6275	0.1604	0.0044	0.0078	0.2018	0.0048	0.0089												
IND105 R	0.5553	0.0081	0.0000	0.0001	0.0065	0.0025	0.0000	0.2886											
IND105 N	0.3632	0.0007	0.0000	0.0000	0.0035	0.0242	0.0000	0.1668	0.6274										
IND123 R	0.2885	0.4641	0.0555	0.0697	0.5505	0.0008	0.0827	0.6252	0.1074	0.1017									
IND123 N	0.0265	0.0478	0.0040	0.0275	0.0088	0.5675	0.0044	0.0628	0.0335	0.1428	0.0153								
IND131 R	0.1113	0.0063	0.0000	0.0004	0.0018	0.0405	0.0001	0.0827	0.2235	0.5093	0.0213	0.0703							
IND131 N	0.0160	0.0126	0.0004	0.0040	0.0019	0.9981	0.0004	0.0312	0.0223	0.1062	0.0073	0.5909	0.1043						
LAW082 R	0.0000	0.0001	0.0002	0.0169	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0014	0.0010	0.0000	0.0000					
LAW082 N	0.9673	0.2741	0.0329	0.0669	0.2340	0.0378	0.0449	0.7953	0.6830	0.5726	0.5184	0.1172	0.2854	0.0941	0.0029				
LAW090 R	0.0032	0.4542	0.4633	0.1277	0.1867	0.0000	0.7095	0.0196	0.0002	0.0000	0.1325	0.0036	0.0001	0.0003	0.0006	0.0622			
LAW090 N	0.0005	0.0014	0.0014	0.0118	0.0022	0.0001	0.0020	0.0012	0.0000	0.0000	0.0159	0.0186	0.0002	0.0019	0.7886	0.0229	0.0051		
LAW118 R	0.0000	0.0005	0.0031	0.1413	0.0005	0.0000	0.0028	0.0001	0.0000	0.0000	0.0046	0.0014	0.0000	0.0000	0.0688	0.0044	0.0048	0.0455	
LAW118 N	0.0552	0.9824	0.0611	0.0036	0.6602	0.0008	0.1664	0.1398	0.0079	0.0001	0.4626	0.0473	0.0073	0.0119	0.0000	0.2646	0.3974	0.0001	0.0001

Table A68. P values for organic nitrogen.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0277																		
BIS097 R	0.0082	0.6211																	
BIS097 N	0.0090	0.3659	0.1516																
BLK016 R	0.2691	0.0090	0.0089	0.0004															
BLK016 N	0.0016	0.0001	0.0000	0.0000	0.0001														
FSL201 R	0.0006	0.3724	0.0993	0.8677	0.0001	0.0000													
FSL201 N	0.2632	0.1029	0.1103	0.0188	0.6400	0.0004	0.0055												
IND105 R	0.7300	0.0002	0.0001	0.0000	0.0322	0.0002	0.0000	0.0415											
IND105 N	0.2419	0.0000	0.0000	0.0000	0.0019	0.0148	0.0000	0.0067	0.1179										
IND123 R	0.1583	0.2619	0.2579	0.1036	0.4849	0.0001	0.0358	0.8225	0.0387	0.0145									
IND123 N	0.0072	0.0097	0.0008	0.0071	0.0025	0.4770	0.0004	0.0127	0.0063	0.0724	0.0024								
IND131 R	0.0245	0.0001	0.0000	0.0000	0.0004	0.0377	0.0000	0.0022	0.0137	0.2911	0.0008	0.0360							
IND131 N	0.0086	0.0016	0.0001	0.0008	0.0008	0.8077	0.0000	0.0045	0.0044	0.0756	0.0013	0.4118	0.1344						
LAW082 R	0.0000	0.0058	0.0005	0.0213	0.0000	0.0000	0.0072	0.0001	0.0000	0.0000	0.0015	0.0001	0.0000	0.0000					
LAW082 N	0.3798	0.3298	0.2978	0.1731	0.7514	0.0040	0.0742	0.9911	0.1687	0.0871	0.8738	0.0261	0.0163	0.0168	0.0091				
LAW090 R	0.0003	0.1622	0.0303	0.6322	0.0000	0.0000	0.4673	0.0015	0.0000	0.0000	0.0169	0.0002	0.0000	0.0000	0.0349	0.0403			
LAW090 N	0.0009	0.0063	0.0019	0.0038	0.0000	0.0000	0.0054	0.0007	0.0000	0.0000	0.0107	0.0037	0.0000	0.0002	0.5186	0.0337	0.0192		
LAW118 R	0.0000	0.0005	0.0001	0.0005	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0009	0.0001	0.0000	0.0000	0.8871	0.0044	0.0070	0.3700	
LAW118 N	0.0258	0.9979	0.6065	0.2920	0.0083	0.0001	0.3351	0.0896	0.0003	0.0000	0.2597	0.0095	0.0002	0.0014	0.0043	0.3207	0.1346	0.0021	0.0003

Table A69. P values for leachable carbon.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.2665																		
BIS097 R	0.0611	0.3871																	
BIS097 N	0.1400	0.1307	0.4966																
BLK016 R	0.6701	0.3230	0.0763	0.1379															
BLK016 N	0.2337	0.7956	0.5545	0.1651	0.2780														
FSL201 R	0.2054	0.8225	0.3800	0.3583	0.3254	0.7108													
FSL201 N	0.4654	0.5268	0.1737	0.2057	0.6540	0.4428	0.6642												
IND105 R	0.0810	0.6426	0.8715	0.5958	0.1113	0.7898	0.4944	0.2687											
IND105 N	0.4842	0.5152	0.1606	0.1747	0.6548	0.4239	0.6909	0.9820	0.2793										
IND123 R	0.4129	0.5408	0.1949	0.2507	0.6490	0.4672	0.6103	0.9643	0.2607	0.9482									
IND123 N	0.1877	0.1630	0.0383	0.1282	0.1245	0.1549	0.0626	0.1747	0.0423	0.2116	0.0913								
IND131 R	0.1983	0.6306	0.1514	0.1181	0.3159	0.4802	0.8980	0.6673	0.2967	0.6854	0.6364	0.0554							
IND131 N	0.9015	0.1607	0.0220	0.0475	0.7903	0.1260	0.2256	0.4852	0.0528	0.4756	0.5056	0.2976	0.1610						
LAW082 R	0.0458	0.1122	0.6460	0.4590	0.0518	0.1881	0.2660	0.1014	0.6425	0.0798	0.1392	0.0305	0.0614	0.0079					
LAW082 N	0.2022	0.1076	0.0175	0.0740	0.1121	0.0994	0.0401	0.1347	0.0212	0.1641	0.0723	0.8283	0.0356	0.2719	0.0148				
LAW090 R	0.4501	0.2446	0.0300	0.0467	0.7378	0.1793	0.3766	0.7880	0.0733	0.7655	0.8330	0.0847	0.3410	0.4893	0.0121	0.0603			
LAW090 N	0.1954	0.5429	0.8825	0.3926	0.2222	0.7000	0.5716	0.3496	0.9810	0.3264	0.3829	0.1447	0.3242	0.0947	0.5166	0.0897	0.1245		
LAW118 R	0.0760	0.5439	0.6496	0.1975	0.0996	0.7747	0.4949	0.2193	0.8872	0.2002	0.2502	0.0370	0.2314	0.0233	0.2528	0.0162	0.0445	0.8281	
LAW118 N	0.8787	0.0092	0.0003	0.0004	0.5149	0.0048	0.0690	0.2143	0.0043	0.1860	0.2687	0.3360	0.0200	0.6978	0.0000	0.3178	0.1737	0.0029	0.0003

Table A70. P values for leachable nitrogen.																	
Names	BGP R	BGP N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																	
BGP N	0.2345																
BLK016 R	0.1187	0.6373															
BLK016 N	0.6083	0.0055	0.3069														
FSL201 R	0.2581	0.5804	0.7514	0.6298													
FSL201 N	0.3418	0.3821	0.5704	0.6705	0.8678												
IND105 R	0.5722	0.4151	0.9308	0.0000	0.9359	0.8335											
IND105 N	0.3928	0.4771	0.9804	0.0277	0.8317	0.6717	0.8337										
IND123 R	0.1713	0.6616	0.8510	0.5803	0.9151	0.7823	0.9815	0.8983									
IND123 N	0.0075	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000								
IND131 R	0.2557	0.1086	0.1612	0.9302	0.4643	0.6023	0.5493	0.3238	0.3659	0.0000							
IND131 N	0.2852	0.4335	0.7396	0.4494	0.9808	0.8217	0.9182	0.7701	0.9322	0.0000	0.4011						
LAW082 R	0.0414	0.7330	0.3251	0.0189	0.2850	0.1372	0.4431	0.4054	0.3664	0.0000	0.0129	0.1877					
LAW082 N	0.7339	0.2156	0.0963	0.5228	0.2085	0.2777	0.5461	0.3621	0.1354	0.0269	0.1650	0.2369	0.0395				
LAW090 R	0.0413	0.0591	0.0762	0.0000	0.1207	0.0362	0.0327	0.0194	0.1716	0.0000	0.0032	0.0333	0.1882	0.0411			
LAW090 N	0.1263	0.0136	0.1203	0.0000	0.2033	0.0857	0.0001	0.0030	0.2544	0.0000	0.0161	0.0681	0.1533	0.1352	0.4117		
LAW118 R	0.1157	0.2466	0.2411	0.0005	0.2885	0.1349	0.1102	0.0927	0.3594	0.0000	0.0239	0.1357	0.5316	0.1138	0.4730	0.1536	
LAW118 N	0.3047	0.1854	0.4008	0.6407	0.7569	0.9015	0.6941	0.4735	0.6660	0.0000	0.6469	0.6717	0.0502	0.2341	0.0063	0.0160	0.0361

Table A71. P values for biomass.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0022																		
BIS097 R	0.0264	0.0001																	
BIS097 N	0.1862	0.2287	0.0321																
BLK016 R	0.0001	0.0000	0.0293	0.0045															
BLK016 N	0.0055	0.5453	0.0017	0.1565	0.0007														
FSL201 R	0.0005	0.0000	0.1001	0.0071	0.5171	0.0004													
FSL201 N	0.0010	0.7272	0.0002	0.1321	0.0000	0.7074	0.0001												
IND105 R	0.0000	0.0000	0.0094	0.0033	0.7016	0.0003	0.2758	0.0000											
1ND105 N	0.0004	0.9312	0.0000	0.1983	0.0000	0.4862	0.0000	0.6408	0.0000										
IND123 R	0.3178	0.0031	0.8183	0.1230	0.2308	0.0037	0.3311	0.0011	0.1879	0.0015									
IND123 N	0.0002	0.9127	0.0000	0.1454	0.0000	0.5688	0.0000	0.7800	0.0000	0.8157	0.0014								
IND131 R	0.0224	0.0002	0.5707	0.0245	0.2983	0.0009	0.5193	0.0001	0.2042	0.0000	0.5880	0.0000							
IND131 N	0.0002	0.0423	0.0001	0.0118	0.0000	0.1415	0.0000	0.0463	0.0000	0.0339	0.0002	0.0409	0.0001						
LAW082 R	0.0000	0.0000	0.0022	0.0023	0.2522	0.0002	0.0755	0.0000	0.2741	0.0000	0.1346	0.0000	0.1090	0.0000					
LAW082 N	0.9672	0.0198	0.0678	0.3497	0.0010	0.0411	0.0032	0.0133	0.0002	0.0053	0.4602	0.0032	0.0750	0.0037	0.0001				
LAW090 R	0.0007	0.0000	0.2399	0.0096	0.0549	0.0006	0.3090	0.0000	0.0032	0.0000	0.4854	0.0000	0.8783	0.0000	0.0000	0.0017			
LAW090 N	0.3800	0.0114	0.5011	0.2098	0.0427	0.0281	0.0889	0.0077	0.0221	0.0030	0.8436	0.0019	0.3661	0.0028	0.0103	0.4809	0.1360		
LAW118 R	0.0002	0.0000	0.0492	0.0055	0.6129	0.0004	0.8118	0.0000	0.2870	0.0000	0.2876	0.0000	0.4176	0.0000	0.0441	0.0006	0.1068	0.0504	
LAW118 N	0.0026	0.4454	0.0008	0.1124	0.0003	0.9094	0.0004	0.5952	0.0002	0.3850	0.0028	0.4601	0.0007	0.1591	0.0002	0.0249	0.0004	0.0168	0.0003

Table A72. P values for sterols.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.9069																		
BIS097 R	0.0998	0.2514																	
BIS097 N	0.0614	0.1881	0.1675																
BLK016 R	0.0187	0.1673	0.0009	0.0133															
BLK016 N	0.0012	0.0156	0.0023	0.0966	0.0006														
FSL201 R	0.0053	0.0942	0.0003	0.0098	0.6442	0.0002													
FSL201 N	0.0055	0.0430	0.0174	0.5018	0.0014	0.1747	0.0011												
IND105 R	0.0042	0.0944	0.0002	0.0101	0.7722	0.0002	0.8172	0.0007											
1ND105 N	0.0031	0.0445	0.0689	0.7081	0.0001	0.0450	0.0001	0.2330	0.0000										
IND123 R	0.7485	0.8891	0.1834	0.0726	0.2702	0.0009	0.1741	0.0068	0.1974	0.0326									
IND123 N	0.0005	0.0088	0.0015	0.2039	0.0001	0.4076	0.0001	0.4950	0.0001	0.0529	0.0011								
IND131 R	0.0036	0.0895	0.0002	0.0099	0.7609	0.0002	0.8215	0.0007	0.9907	0.0000	0.1937	0.0000							
IND131 N	0.0001	0.0032	0.0003	0.0513	0.0000	0.9578	0.0000	0.1203	0.0000	0.0132	0.0002	0.3450	0.0000						
LAW082 R	0.0000	0.0008	0.0000	0.0017	0.0010	0.0001	0.0023	0.0001	0.0001	0.0000	0.0077	0.0000	0.0001	0.0000					
LAW082 N	0.9550	0.9716	0.2849	0.1951	0.1641	0.0160	0.0955	0.0462	0.0957	0.0514	0.8617	0.0093	0.0912	0.0033	0.0015				
LAW090 R	0.0000	0.0041	0.0000	0.0031	0.0169	0.0001	0.0447	0.0002	0.0070	0.0000	0.0252	0.0000	0.0052	0.0000	0.0006	0.0043			
LAW090 N	0.0013	0.0559	0.0004	0.0400	0.1287	0.0061	0.2201	0.0083	0.0951	0.0001	0.1300	0.0015	0.0850	0.0008	0.0327	0.0567	0.7661		
LAW118 R	0.0006	0.0297	0.0000	0.0054	0.1570	0.0002	0.3053	0.0004	0.1799	0.0000	0.0626	0.0000	0.1752	0.0000	0.0710	0.0288	0.5204	0.7686	
LAW118 N	0.0012	0.0166	0.0045	0.3790	0.0003	0.2437	0.0002	0.8326	0.0002	0.1166	0.0029	0.6246	0.0002	0.1707	0.0000	0.0176	0.0001	0.0021	0.0001

Table A73. P values for d13C carbon isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0947																		
BIS097 R	0.6913	0.0271																	
BIS097 N	0.0025	0.0038	0.0028																
BLK016 R	0.0000	0.0000	0.0000	0.0000															
BLK016 N	0.0002	0.0022	0.0003	0.0757	0.0002														
FSL201 R	0.0026	0.0030	0.0035	0.6424	0.0000	0.0079													
FSL201 N	0.0018	0.0058	0.0021	0.5002	0.0000	0.1877	0.2026												
IND105 R	0.0000	0.0000	0.0000	0.0016	0.0000	0.7440	0.0000	0.0159											
1ND105 N	0.0000	0.0000	0.0000	0.0000	0.0022	0.0524	0.0000	0.0001	0.0074										
IND123 R	0.0000	0.0000	0.0000	0.0025	0.0000	0.8294	0.0001	0.0391	0.3650	0.0001									
IND123 N	0.0000	0.0000	0.0000	0.0893	0.0000	0.3528	0.0156	0.4943	0.0549	0.0000	0.1277								
IND131 R	0.0236	0.0670	0.0264	0.3927	0.0010	0.6916	0.1613	0.5749	0.4085	0.0847	0.6573	0.8390							
IND131 N	0.0000	0.0000	0.0000	0.0025	0.0012	0.3657	0.0001	0.0136	0.2755	0.2291	0.0705	0.0218	0.2811						
LAW082 R	0.0000	0.0000	0.0000	0.0000	0.0792	0.0085	0.0000	0.0000	0.0006	0.4437	0.0000	0.0000	0.0093	0.0735					
LAW082 N	0.0084	0.0158	0.0097	0.8869	0.0000	0.1138	0.5583	0.6307	0.0067	0.0000	0.0118	0.2093	0.4420	0.0065	0.0000				
LAW090 R	0.0000	0.0000	0.0000	0.0000	0.1622	0.0012	0.0000	0.0000	0.0000	0.0888	0.0000	0.0000	0.0036	0.0114	0.5114	0.0000			
LAW090 N	0.0000	0.0000	0.0000	0.0000	0.0301	0.0007	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.0044	0.0014	0.0129	0.0000	0.0092		
LAW118 R	0.0000	0.0000	0.0000	0.0000	0.1252	0.0009	0.0000	0.0000	0.0000	0.0635	0.0000	0.0000	0.0034	0.0085	0.5061	0.0000	0.9818	0.0038	
LAW118 N	0.0000	0.0000	0.0000	0.0062	0.0000	0.7509	0.0006	0.1180	0.3189	0.0000	0.7551	0.1768	0.8268	0.0874	0.0004	0.0335	0.0000	0.0000	0.0000

Table A74. P values for d15N nitrogen isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0362																		
BIS097 R	0.0001	0.2562																	
BIS097 N	0.0029	0.3877	0.9341																
BLK016 R	0.0008	0.3752	0.9417	0.9046															
BLK016 N	0.5047	0.4084	0.0471	0.1389	0.0847														
FSL201 R	0.0107	0.7363	0.5079	0.5980	0.5878	0.2239													
FSL201 N	0.7947	0.1722	0.0099	0.0528	0.0191	0.5774	0.0636												
IND105 R	0.9578	0.0844	0.0010	0.0109	0.0033	0.5872	0.0234	0.7915											
1ND105 N	0.0003	0.0002	0.0000	0.0000	0.0000	0.0055	0.0001	0.0267	0.0014										
IND123 R	0.5328	0.6387	0.2006	0.3504	0.2271	0.9165	0.3853	0.5600	0.5665	0.0241									
IND123 N	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0013	0.0000	0.1234	0.0048								
IND131 R	0.0327	0.8535	0.4720	0.5774	0.5376	0.3231	0.8980	0.1034	0.0535	0.0002	0.4543	0.0000							
IND131 N	0.0010	0.0003	0.0000	0.0000	0.0000	0.0125	0.0002	0.0644	0.0050	0.4688	0.0588	0.0097	0.0009						
LAW082 R	0.0002	0.2004	0.6127	0.7679	0.6142	0.0392	0.3279	0.0079	0.0011	0.0000	0.1461	0.0000	0.3171	0.0000					
LAW082 N	0.0047	0.2403	0.3348	0.5235	0.3619	0.1055	0.2516	0.0418	0.0105	0.0004	0.1916	0.0000	0.2615	0.0007	0.5343				
LAW090 R	0.0000	0.0001	0.0000	0.0008	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0016	0.0000	0.0004	0.0000	0.0004	0.0753			
LAW090 N	0.0152	0.5047	0.9179	0.9768	0.8943	0.2163	0.6323	0.0901	0.0330	0.0005	0.3693	0.0000	0.6041	0.0008	0.8418	0.5995	0.0086		
LAW118 R	0.0000	0.0262	0.0338	0.1344	0.0474	0.0060	0.0260	0.0012	0.0001	0.0000	0.0262	0.0000	0.0324	0.0000	0.1100	0.6499	0.0642	0.2097	
LAW118 N	0.0152	0.7916	0.4226	0.5257	0.5478	0.2967	0.9351	0.1206	0.0493	0.0001	0.5435	0.0000	0.9711	0.0001	0.3145	0.3024	0.0003	0.6252	0.0460

Table A75. P values for leachable d13C carbon isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.7445																		
BIS097 R	0.6574	0.0573																	
BIS097 N	0.0185	0.0561	0.1706																
BLK016 R	0.2610	0.4512	0.4944	0.1200															
BLK016 N	0.3442	0.5535	0.5486	0.0939	0.6690														
FSL201 R	0.4099	0.3037	0.7841	0.0889	0.3116	0.3300													
FSL201 N	0.3550	0.0481	0.4320	0.2364	0.4698	0.4857	0.8770												
IND105 R	0.2089	0.0015	0.0093	0.5368	0.5680	0.5668	0.5397	0.3973											
1ND105 N	0.1560	0.0003	0.0027	0.2983	0.4378	0.4237	0.5608	0.4137	0.0025										
IND123 R	0.8933	0.7141	0.7949	0.0148	0.2177	0.2928	0.5276	0.5037	0.3245	0.2795									
IND123 N	0.6818	0.3781	0.9346	0.0983	0.4126	0.4591	0.7147	0.5371	0.2600	0.2097	0.8158								
IND131 R	0.4478	0.6289	0.6237	0.1377	0.6131	0.9473	0.4408	0.5706	0.6237	0.5206	0.3968	0.5528							
IND131 N	0.1271	0.0603	0.3531	0.1294	0.2726	0.2490	0.5723	0.7068	0.6984	0.8895	0.2230	0.3027	0.3783						
LAW082 R	0.0099	0.0189	0.1043	0.4594	0.1317	0.0806	0.0814	0.1872	0.5823	0.2945	0.0160	0.0565	0.1709	0.1498					
LAW082 N	0.2315	0.4065	0.2341	0.0110	0.4065	0.6272	0.1108	0.1284	0.1194	0.0577	0.2320	0.2003	0.6683	0.0315	0.0043				
LAW090 R	0.0428	0.0867	0.2753	0.2988	0.0930	0.0782	0.2204	0.4071	0.7988	0.5628	0.0500	0.1797	0.1418	0.3793	0.6964	0.0150			
LAW090 N	0.6004	0.5934	0.8790	0.2803	0.4801	0.5303	0.9672	0.9681	0.8247	0.8179	0.6683	0.8251	0.5939	0.7967	0.2989	0.3254	0.4520		
LAW118 R	0.0690	0.0383	0.2402	0.1747	0.2509	0.2125	0.3818	0.5016	0.9037	0.8230	0.1313	0.1915	0.3411	0.6987	0.2522	0.0210	0.5356	0.6612	
LAW118 N	0.9423	0.7420	0.5301	0.0216	0.3134	0.3876	0.3574	0.2339	0.1005	0.0643	0.8469	0.5914	0.4991	0.0864	0.0098	0.2437	0.0538	0.5796	0.0456

Table A76. P values for leachable d15N nitrogen isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.6721																		
BIS097 R	0.1196	0.2398																	
BIS097 N	0.0552	0.0695	0.1077																
BLK016 R	0.0064	0.0490	0.0226	0.2749															
BLK016 N	0.3545	0.4129	0.8526	0.3732	0.2310														
FSL201 R	0.0627	0.1045	0.2303	0.6741	0.1520	0.5451													
FSL201 N	0.2013	0.4659	0.4522	0.8850	0.6031	0.7341	0.7580												
IND105 R	0.2521	0.1893	0.1767	0.8321	0.6536	0.3780	0.6380	0.9874											
1ND105 N	0.0079	0.0054	0.0008	0.0242	0.4164	0.0227	0.0114	0.4686	0.2194										
IND123 R	0.2591	0.4811	0.2925	0.4589	0.3652	0.5886	0.3959	0.4699	0.7251	0.6765									
IND123 N	0.4811	0.5814	0.6773	0.1665	0.1652	0.6072	0.2829	0.6571	0.0001	0.0076	0.5863								
IND131 R	0.0209	0.0912	0.1885	0.7706	0.0902	0.5257	0.8963	0.7239	0.7260	0.0074	0.2488	0.3034							
IND131 N	0.0187	0.1201	0.0344	0.1713	0.2278	0.2698	0.1058	0.2838	0.5418	0.7183	0.6086	0.2399	0.0395						
LAW082 R	0.1079	0.3488	0.2901	0.6845	0.8310	0.6017	0.5530	0.8190	0.8829	0.5809	0.3195	0.5310	0.4621	0.2604					
LAW082 N	0.0690	0.1809	0.2580	0.9110	0.2364	0.5893	0.8321	0.8368	0.8448	0.0518	0.4044	0.4044	0.8974	0.1243	0.6225				
LAW090 R	0.2454	0.4651	0.2633	0.4196	0.3002	0.5672	0.3586	0.4253	0.7023	0.6153	0.6520	0.5627	0.2134	0.4960	0.2611	0.3616			
LAW090 N	0.0431	0.1937	0.0734	0.2763	0.3927	0.3783	0.1880	0.4252	0.6562	0.8640	0.6358	0.3417	0.0912	0.8630	0.4367	0.2222	0.5501		
LAW118 R	0.0889	0.2920	0.1212	0.2927	0.2302	0.4375	0.2211	0.3250	0.6390	0.6246	0.7721	0.4214	0.1020	0.6221	0.2029	0.2317	0.5826	0.6133	
LAW118 N	0.0456	0.0264	0.1038	0.5777	0.1353	0.2720	0.9814	0.7549	0.2540	0.0007	0.3990	0.0152	0.8995	0.0992	0.5546	0.8205	0.3604	0.1754	0.2181

Table A77. P values for organic d13C carbon isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0035																		
BIS097 R	0.3191	0.0000																	
BIS097 N	0.0020	0.0005	0.0035																
BLK016 R	0.1330	0.6498	0.0882	0.0380															
BLK016 N	0.1743	0.0140	0.3398	0.1717	0.1586														
FSL201 R	0.5026	0.0037	0.9144	0.0063	0.0975	0.3832													
FSL201 N	0.9993	0.3819	0.7639	0.1453	0.3053	0.5878	0.8036												
IND105 R	0.1793	0.6956	0.1264	0.0573	0.9838	0.1969	0.1369	0.3436											
1ND105 N	0.0027	0.0000	0.0044	0.2841	0.0881	0.4642	0.0298	0.3249	0.1237										
IND123 R	0.7281	0.4074	0.8826	0.3955	0.2056	0.8792	0.8640	0.8100	0.2219	0.6647									
IND123 N	0.3258	0.6430	0.2912	0.2883	0.6984	0.4169	0.2973	0.4697	0.6845	0.3601	0.3263								
IND131 R	0.2872	0.0917	0.4491	0.3159	0.0694	0.9194	0.4411	0.5139	0.0896	0.7243	0.7846	0.2393							
IND131 N	0.0004	0.0000	0.0005	0.9629	0.0372	0.1109	0.0026	0.1224	0.0572	0.1604	0.3815	0.2829	0.2888						
LAW082 R	0.7877	0.4999	0.9189	0.4692	0.2834	0.8877	0.9029	0.8515	0.2982	0.7075	0.9873	0.3919	0.8020	0.4531					
LAW082 N	0.8195	0.0866	0.3910	0.0229	0.3243	0.3147	0.5296	0.9360	0.3791	0.0337	0.7686	0.5139	0.4146	0.0082	0.8177				
LAW090 R	0.0976	0.1062	0.1297	0.7685	0.0344	0.3901	0.1281	0.2278	0.0363	0.5136	0.2643	0.1426	0.2875	0.7797	0.3242	0.2263			
LAW090 N	0.0520	0.2300	0.0459	0.0980	0.1745	0.1430	0.0473	0.1438	0.1614	0.1217	0.0658	0.5434	0.0419	0.0957	0.1051	0.1789	0.0326		
LAW118 R	0.7574	0.9862	0.6977	0.5151	0.8122	0.7115	0.7058	0.8163	0.8137	0.6312	0.6773	0.6763	0.5786	0.5087	0.7199	0.8476	0.3042	0.2660	
LAW118 N	0.1243	0.9620	0.0519	0.0123	0.6532	0.1116	0.0850	0.4728	0.6937	0.0213	0.4440	0.6417	0.1441	0.0064	0.5302	0.3534	0.1256	0.2315	0.9934

Table A78. P values for organic d15N nitrogen isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.0222																		
BIS097 R	0.0021	0.5176																	
BIS097 N	0.0267	0.5739	0.8380																
BLK016 R	0.0032	0.6014	0.8776	0.7671															
BLK016 N	0.3386	0.3106	0.2626	0.4795	0.2600														
FSL201 R	0.1793	0.2795	0.3227	0.5554	0.2953	0.8570													
FSL201 N	0.3515	0.3131	0.2906	0.5109	0.2788	0.9933	0.8635												
IND105 R	0.6668	0.0510	0.0167	0.0940	0.0189	0.5505	0.3430	0.5498											
IND105 N	0.0019	0.0017	0.0000	0.0003	0.0000	0.0096	0.0028	0.0121	0.0028										
IND123 R	0.6535	0.2607	0.2360	0.4477	0.2187	0.8303	0.6489	0.8153	0.8403	0.0455									
IND123 N	0.0000	0.0002	0.0000	0.0000	0.0000	0.0007	0.0003	0.0014	0.0001	0.3250	0.0142								
IND131 R	0.1173	0.4153	0.5610	0.7649	0.5115	0.6948	0.7773	0.6949	0.2315	0.0019	0.5086	0.0002							
IND131 N	0.0208	0.0065	0.0001	0.0022	0.0003	0.0403	0.0149	0.0472	0.0224	0.4152	0.1401	0.0570	0.0137						
LAW082 R	0.1465	0.6439	0.3836	0.5218	0.4006	0.4084	0.2720	0.3685	0.1732	0.1004	0.2168	0.0675	0.3155	0.1465					
LAW082 N	0.0210	0.9704	0.4861	0.5495	0.5672	0.2984	0.2680	0.3009	0.0526	0.0018	0.2536	0.0002	0.3971	0.0065	0.6561				
LAW090 R	0.0000	0.1376	0.0030	0.0182	0.0057	0.0068	0.0023	0.0065	0.0001	0.0000	0.0053	0.0000	0.0066	0.0000	0.9657	0.1536			
LAW090 N	0.6180	0.2443	0.1652	0.3626	0.1668	0.8078	0.6414	0.8019	0.8400	0.0280	0.9912	0.0034	0.5165	0.0962	0.3686	0.2351	0.0066		
LAW118 R	0.0003	0.0347	0.0019	0.0195	0.0022	0.0121	0.0012	0.0071	0.0004	0.0009	0.0011	0.0004	0.0016	0.0017	0.1485	0.0362	0.0250	0.0098	
LAW118 N	0.0023	0.7719	0.1871	0.2660	0.2690	0.1355	0.1265	0.1520	0.0107	0.0001	0.1580	0.0000	0.2248	0.0006	0.7121	0.8080	0.1933	0.1086	0.0466

Table A79. P values for loss on ignition.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP R																			
BGP N	0.5751																		
BIS097 R	0.0006	0.0599																	
BIS097 N	0.4529	0.5091	0.3345																
BLK016 R	0.0000	0.0396	0.0000	0.0009															
BLK016 N	0.0000	0.0000	0.0000	0.0000	0.0000														
FSL201 R	0.0428	0.1890	0.1754	0.7915	0.0000	0.0000													
FSL201 N	0.0006	0.0713	0.0000	0.0118	0.2767	0.0001	0.0002												
IND105 R	0.0000	0.0009	0.0000	0.0000	0.0017	0.0000	0.0000	0.3457											
IND105 N	0.0000	0.0004	0.0000	0.0000	0.0000	0.0104	0.0000	0.0157	0.0042										
IND123 R	0.5262	0.4727	0.3426	0.9761	0.0015	0.0000	0.7662	0.0047	0.0000	0.0000									
IND123 N	0.0029	0.0599	0.0007	0.0247	0.0593	0.0650	0.0014	0.3211	0.3699	0.6730	0.0052								
IND131 R	0.0000	0.0180	0.0000	0.0007	0.2325	0.0000	0.0000	0.7737	0.0714	0.0002	0.0005	0.1305							
IND131 N	0.0027	0.0406	0.0011	0.0234	0.0182	0.6803	0.0017	0.1143	0.0704	0.5214	0.0032	0.4323	0.0322						
LAW082 R	0.0000	0.0061	0.0097	0.0342	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0540	0.0001	0.0000	0.0003					
LAW082 N	0.0016	0.1702	0.9904	0.4700	0.0000	0.0000	0.2596	0.0010	0.0000	0.0000	0.4974	0.0100	0.0000	0.0144	0.0080				
LAW090 R	0.0087	0.1544	0.1139	0.7447	0.0000	0.0000	0.9425	0.0000	0.0000	0.0000	0.7336	0.0007	0.0000	0.0009	0.0000	0.1271			
LAW090 N	0.0005	0.1041	0.3671	0.2831	0.0000	0.0000	0.0738	0.0006	0.0000	0.0000	0.3106	0.0074	0.0000	0.0119	0.2286	0.3777	0.0253		
LAW118 R	0.0000	0.0131	0.0818	0.0796	0.0000	0.0000	0.0039	0.0000	0.0000	0.0000	0.1094	0.0002	0.0000	0.0004	0.1617	0.0641	0.0003	0.7244	
LAW118 N	0.1382	0.7820	0.0030	0.2516	0.0260	0.0000	0.0232	0.0628	0.0004	0.0000	0.2647	0.0618	0.0142	0.0434	0.0001	0.0136	0.0099	0.0069	0.0002

Tukey Tables

The F test as usually applied to pair-wise comparisons in ANOVA is properly interpreted only for each comparison separately. To give proper interpretations when there are many pair-wise comparisons to be considered together, the more stringently calculated Tukey's test of honestly significant differences (HSD) should be used. Tukey calculated the distribution of the largest F statistic among multiple pairs when there were no underlying differences. Thus Tukey's test is more stringent, because the F statistic will be larger. The null hypothesis for Tukey's test is again that any observed differences between means are due to random chance.

The correct formulas become quite involved for more than a few pairs of means of samples, but simplified expressions are available when the measurements have the same number of observations for each sample mean. When there are different numbers of observations, as is the case for our

measurements, these simplified expressions are no longer correct.The usual unequal sample size modifications such as the harmonic means approximations of Tukey's HSD make it incorrectly more stringent; the true significance level is no greater than the observed significance level.

When there are many differing small numbers of observations, the proper calculations can be difficult to implement. We used a shareware package for Excel by the Instituto Nacional de Enfermedades Respiratorias de México, inerSTAT (http://www.winsite.com/info/pc/win95/excel/inerst13.zip), that reports the results of Tukey's test for up to 20 differing numbers of observations of sample means. For each pair of sample means, the reported p-value for Tukey's test is in the context of other pairs of means.

In the following tables the Tukey P values that are less than 0.05 are highlighted in green. For these P values the means of corresponding pairs of samples are significantly different at the $\alpha = 0.05$ level, while for the unhighlighted P values the means of corresponding pairs of samples are not significantly different at the $\alpha = 0.05$ level. For instance, from the sand Tukey P value table, reading down the first column, BGP R is not significantly different from BGP N but is significantly different from BLK016 R.

Table A80. Tukey values for % sand.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	p<0.01	p<0.01	p<0.01	p<0.01															
BLK016 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	p<0.01	p<0.01	p<0.01	p<0.01	p<0.05	n.s.	p<0.01	p<0.01											
IND105 N	p<0.05	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	p<0.05	p<0.05	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.									
IND123 N	n.s.	n.s.	p<0.05	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.								
IND131 R	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.05	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.05	p<0.05	n.s.	p<0.01	p<0.01	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.05	p<0.05	n.s.	p<0.01	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A81. Tukey values for % silt.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	p<0.01	p<0.01	p<0.01	p<0.01															
BLK016 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01													
FSL201 N	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.												
IND105 R	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01											
IND105 N	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.									
IND123 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.								
IND131 R	p<0.01	p<0.01	p<0.01	p<0.01	p<0.05	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01						
LAW082 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	p<0.05	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	p<0.05	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A82. Tukey values for % clay.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	p<0.05	p<0.05	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01											
IND105 N	n.s.	p<0.01	p<0.05	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.										
IND123 R	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.								
IND131 R	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.							
IND131 N	n.s.	p<0.01	n.s.	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	p<0.05	p<0.05	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	p<0.01	n.s.	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	p<0.01	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	p<0.05	p<0.05	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A83. Tukey values for carbon.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	p<0.01	p<0.01	p<0.01	p<0.01															
BLK016 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01													
FSL201 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.												
IND105 R	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.05											
1ND105 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01									
IND123 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	p<0.05	n.s.	p<0.01								
IND131 R	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	n.s.							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	p<0.05	n.s.	p<0.01	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.05	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.

Table A84. Tukey values for total nitrogen.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.									
IND123 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01								
IND131 R	n.s.	p<0.05	p<0.01	p<0.01	p<0.05	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	p<0.01							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	n.s.						
LAW082 R	p<0.05	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.05	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.05	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	p<0.05	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.

Table A85. Tukey values for leachable carbon.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	n.s.	p<0.05	n.s.	p<0.01	p<0.05	p<0.01	p<0.05	n.s.	n.s.	n.s.	p<0.01								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01							
IND131 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A86. Tukey values for leachable nitrogen.																	
Names	BGP R	BGP N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																
BLK016 R	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01							
IND131 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.05			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A87. Tukey values for organic carbon.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	p<0.05	p<0.01	p<0.01	p<0.01	p<0.01														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.									
IND123 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01								
IND131 R	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	p<0.01							
IND131 N	p<0.05	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.05	n.s.	n.s.	p<0.01	p<0.01	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.

Table A88. Tukey values for organic nitrogen.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.									
IND123 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01								
IND131 R	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.05	p<0.01							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.05	n.s.	p<0.01	n.s.	n.s.						
LAW082 R	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.05	p<0.05	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.05	p<0.05	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.

Table A89. Tukey values for PLFAME.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	p<0.05																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	p<0.01	n.s.	n.s.															
BLK016 N	p<0.01	n.s.	p<0.01	n.s.	p<0.01														
FSL201 R	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01													
FSL201 N	p<0.05	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01												
IND105 R	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01											
1ND105 N	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.05	n.s.	p<0.01										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.									
IND123 N	n.s.	n.s.	p<0.05	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.05								
IND131 R	n.s.	p<0.05	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.05	n.s.	p<0.05							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01						
LAW082 R	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.				
LAW090 R	n.s.	p<0.05	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.05	n.s.	p<0.05	n.s.	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.05	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	p<0.05	p<0.01	p<0.01	p<0.01

Table A90. Tukey values for sterols																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01													
FSL201 N	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.05	n.s.	n.s.									
IND123 N	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	p<0.01						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	p<0.01	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.05	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	p<0.05	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.05	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	p<0.01	p<0.01

Table A91. Tukey values for %total d13C carbon isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	p<0.01	p<0.01	p<0.01	p<0.01															
BLK016 N	p<0.01	p<0.01	p<0.01	n.s.	p<0.01														
FSL201 R	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.												
IND105 R	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.											
1ND105 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.										
IND123 R	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.								
IND131 R	p<0.01	p<0.05	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	n.s.							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.05	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.						
LAW082 R	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.05	p<0.01	p<0.01	p<0.05	n.s.	p<0.01	p<0.01	p<0.01	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.05	p<0.01				
LAW090 R	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01			
LAW090 N	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.		
LAW118 R	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.05	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	p<0.01	n.s.	n.s.	
LAW118 N	p<0.05	p<0.05	p<0.05	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	p<0.01	p<0.01	p<0.01

Table A92. Tukey values for d15N nitrogen isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05									
IND123 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.05	p<0.01	n.s.	p<0.01								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01							
IND131 N	n.s.	p<0.05	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.				
LAW090 R	p<0.01	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.05	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.05	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	p<0.01	p<0.05	p<0.01	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.01	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.	n.s.

Table A93. Tukey values for leached d13C carbon isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.							
IND131 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A94 Tukey values for leached d15N nitrogen isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.							
IND131 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A95. Tukey values for organic d13C carbon isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.							
IND131 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05		
LAW118 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table A96. Tukey values for organic d15N nitrogen isotopes.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	n.s.	n.s.															
BLK016 N	n.s.	n.s.	n.s.	n.s.	n.s.														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.													
FSL201 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.												
IND105 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.											
1ND105 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.									
IND123 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.								
IND131 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.							
IND131 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.						
LAW082 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	p<0.01	n.s.	n.s.					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05	n.s.	p<0.05	n.s.	n.s.	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.		
LAW118 R	p<0.01	p<0.05	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.05	n.s.	p<0.01	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.05

Table A97. Tukey values for loss on ignition.																			
Names	BGP R	BGP N	BIS R	BIS N	BLK R	BLK N	FSL R	FSL N	I105 R	I105 N	I123 R	I123 N	I131 R	I131 N	L082 R	L082 N	L090 R	L090 N	L118 R
BGP N	n.s.																		
BIS097 R	n.s.	n.s.																	
BIS097 N	n.s.	n.s.	n.s.																
BLK016 R	n.s.	n.s.	p<0.05	n.s.															
BLK016 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01														
FSL201 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01													
FSL201 N	n.s.	n.s.	p<0.05	n.s.	n.s.	p<0.01	n.s.												
IND105 R	p<0.01	n.s.	p<0.01	p<0.05	n.s.	p<0.01	p<0.01	n.s.											
1ND105 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.05	n.s.	p<0.01	n.s.	n.s.										
IND123 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.01									
IND123 N	p<0.01	p<0.05	p<0.01	p<0.01	n.s.	p<0.05	p<0.01	n.s.	n.s.	n.s.	p<0.01								
IND131 R	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.05	n.s.	n.s.	n.s.	p<0.05	n.s.							
IND131 N	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	n.s.	p<0.01						
LAW082 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01					
LAW082 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	n.s.	p<0.01	n.s.				
LAW090 R	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.05	p<0.01	n.s.	n.s.			
LAW090 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	p<0.05	p<0.01	p<0.01	n.s.	p<0.01	p<0.05	p<0.01	n.s.	n.s.	n.s.		
LAW118 R	n.s.	n.s.	n.s.	n.s.	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	p<0.01	p<0.01	p<0.01	n.s.	n.s.	n.s.	n.s.	
LAW118 N	n.s.	n.s.	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	p<0.01	n.s.	n.s.	n.s.	n.s.	n.s.

Condensed bulk parameters

Table A98. Condensed bulk parameters.

Sample Name	Sand				Silt				Clay			
	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey
BGP R	79.60	4.97		C	7.80	3.19		C	12.60	2.67		BC
BGP N	83.60	2.97	0.1232	C	7.60	2.19	0.9022	C	8.80	1.79	0.0129	BC
BIS097 R	83.40	6.60		C	5.40	4.62		C	11.20	2.86		BC
BIS097 N	90.00	2.00	0.0495	C	3.20	1.10	0.3199	C	6.80	2.28	0.0099	B
BLK016 R	58.20	8.92		B	33.40	9.48		B	8.40	2.46		B
BLK016 N	56.80	13.31	0.8106	B	28.80	11.37	0.4194	B	14.40	5.55	0.0103	BC
FSL201 R	75.80	8.13		C	9.80	6.21		C	14.40	3.98		C
FSL201 N	73.33	8.45	0.5712	BC	12.00	6.32	0.5061	C	14.67	4.50	0.9031	BC
IND105 R	43.20	11.20		A	32.60	11.51		B	24.20	2.90		A
IND105 N	60.00	7.48	0.0094	B	20.80	5.76	0.0510	B	19.20	2.28	0.0047	AC
IND123 R	64.40	16.97		B	16.20	13.74		C	19.40	5.42		AC
IND123 N	65.20	6.57	0.9216	B	19.20	10.64	0.6768	BC	15.60	5.90	0.2335	C
IND131 R	37.20	11.00		AB	46.80	7.73		A	16.00	4.90		C
IND131 N	52.80	14.39	0.0343	AB	28.80	13.61	0.0051	B	18.40	6.23	0.4260	AC
LAW082 R	76.80	5.01		C	8.80	3.16		C	14.40	2.95		C
LAW082 N	82.40	2.61	0.0361	C	7.20	1.10	0.2967	C	10.40	1.67	0.0147	BC
LAW090 R	76.60	2.99		C	11.80	2.57		C	11.60	1.58		BC
LAW090 N	82.80	3.35	0.0026	C	7.20	2.28	0.0045	C	10.00	1.41	0.0768	BC
LAW118 R	69.40	10.20		B	15.60	7.04		C	15.00	4.03		C
LAW118 N	66.40	6.07	0.5581	B	21.60	6.99	0.1412	B	12.00	1.41	0.1338	BC
	1377.93											
Number of sites R & N differences			5	1			2	2			5	0

Table A98 (cont.). Condensed bulk parameters.								
	PLFA Biomass				Total Sterols			
Sample Name	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey
BGP R	2462.36	1087.87		C	6283.97	2435.82		B
BGP N	6872.27	3518.99	0.0022	B	6068.73	4695.48	0.9069	B
BIS097 R	1383.76	908.46		C	8463.85	3152.52		B
BIS097 N	4085.82	3480.25	0.0321	BC	14483.84	12761.66	0.1675	B
BLK016 R	575.56	591.50		C	3451.08	2490.48		B
BLK016 N	8849.25	6203.16	0.0007	B	36086.22	23927.61	0.0006	A
FSL201 R	763.62	679.55		C	2947.28	2306.53		B
FSL201 N	7677.26	3908.22	0.0001	B	19908.95	13219.97	0.0011	A
IND105 R	490.18	363.29		C	3164.82	1815.66		B
IND105 N	6700.84	2575.44	0.0000	B	12195.36	4060.76	0.0000	B
IND123 R	1579.32	2495.03		C	5654.95	5608.06		B
IND123 N	7091.34	2623.65	0.0014	B	25583.41	13563.77	0.0011	A
IND131 R	1082.60	1377.74		C	3155.45	1721.96		B
IND131 N	16368.98	8828.99	0.0001	A	35368.15	17812.85	0.0000	A
LAW082 R	342.20	201.64		C	361.92	324.89		B
LAW082 N	2488.36	1231.68	0.0001	C	6178.12	4838.73	0.0015	B
LAW090 R	1013.11	328.42		C	1316.64	660.93		B
LAW090 N	1828.44	1623.25	0.1360	C	1480.48	1475.53	0.7661	B
LAW118 R	699.90	484.20		C	1834.97	2413.86		B
LAW118 N	9294.06	5930.34	0.0003	B	21555.61	11836.96	0.0001	A
Number of sites R & N differences			9	7			7	5

Table A98 (cont.). Condensed bulk parameters.												
	Total Carbon				Total Nitrogen				Total Organic Carbon			
Sample Name	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey
BGP R	24.84	9.81		C	2.46	0.88		B	22.66	9.47		BC
BGP N	16.19	6.24	0.0968	C	1.53	0.50	0.0485	C	13.32	5.32	0.0622	BC
BIS097 R	10.33	3.66		C	1.31	0.50		C	9.65	3.35		C
BIS097 N	8.02	2.26	0.2228	C	0.95	0.24	0.1469	C	7.18	2.10	0.1585	BC
BLK016 R	62.51	7.55		AB	2.06	0.47		C	14.87	6.89		BC
BLK016 N	73.48	9.75	0.0300	AB	4.99	1.35	0.0000	AB	47.40	17.53	0.0001	AB
FSL201 R	14.13	4.94		C	1.19	0.36		C	10.33	4.01		C
FSL201 N	28.14	9.06	0.0011	C	2.19	0.56	0.0005	BC	20.25	9.25	0.0089	BC
IND105 R	59.36	11.93		A	2.74	0.53		B	25.00	7.92		B
IND105 N	73.80	7.37	0.0277	AB	3.28	0.46	0.0689	B	26.92	4.61	0.6274	BC
IND123 R	29.48	16.30		C	1.84	0.93		C	17.47	11.66		BC
IND123 N	91.41	56.48	0.0051	B	6.34	4.09	0.0041	A	60.99	48.85	0.0153	A
IND131 R	62.21	25.96		AB	3.81	1.06		B	30.69	11.90		B
IND131 N	91.45	18.74	0.0429	C	5.32	2.36	0.1029	AB	47.37	26.08	0.1043	AB
LAW082 R	8.27	2.79		C	0.63	0.32		C	3.17	3.05		C
LAW082 N	26.80	17.62	0.0046	C	1.75	1.13	0.0089	BC	22.38	16.97	0.0029	BC
LAW090 R	23.99	5.10		C	1.10	0.35		C	11.12	5.24		BC
LAW090 N	15.58	2.25	0.0038	C	0.55	0.21	0.0074	C	2.73	2.73	0.0051	C
LAW118 R	15.24	2.37		C	0.74	0.15		C	5.43	2.08		C
LAW118 N	25.82	4.31	0.0000	C	1.70	0.32	0.0000	C	13.38	3.36	0.0001	BC
Number of sites R & N differences			8	2			7	3			6	1

Table A98 (cont.). Condensed bulk parameters.												
	Total Organic Nitrogen				Total Leachable Carbon				Total Leachable Nitrogen			
Sample Name	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey
BGP R	1.96	0.85		B	10.62	8.93		ABC	0.87	0.82		BC
BGP N	0.97	0.40	0.0277	C	2.94	1.95	0.2665	BC	0.24	0.11	0.2230	BC
BIS097 R	1.08	0.42		C	4.10	2.09		ABC	0.00	0.00		BC
BIS097 N	0.78	0.21	0.1516	C	0.37	0.35	0.4966	BC	0.00	0.00	0.0000	BC
BLK016 R	1.62	0.41		BC	6.98	6.95		BC	0.32	0.27		BC
BLK016 N	4.08	1.27	0.0001	AB	2.39	1.79	0.2780	BC	0.54	0.01	0.9635	BC
FSL201 R	0.80	0.29		C	5.70	6.55		BC	0.39	0.42		BC
FSL201 N	1.50	0.58	0.0055	BC	10.28	1.63	0.6642	ABC	0.43	0.34	0.6074	BC
IND105 R	2.07	0.45		B	10.12	10.12		ABC	0.35	0.35		BC
IND105 N	2.45	0.35	0.1179	B	8.38	3.33	0.2793	ABC	0.31	0.12	0.2412	BC
IND123 R	1.42	0.81		C	5.09	6.95		BC	0.36	0.44		BC
IND123 N	5.18	3.12	0.0024	A	30.22	26.06	0.0913	A	3.06	0.27	0.0941	A
IND131 R	2.88	0.83		B	3.59	3.09		C	0.52	0.28		BC
IND131 N	3.86	1.60	0.1344	AB	7.29	5.49	0.1610	C	0.38	0.28	0.3277	BC
LAW082 R	0.41	0.29		C	1.04	0.94		C	0.20	0.17		BC
LAW082 N	1.50	1.10	0.0091	BC	15.15	17.28	0.0148	AC	1.06	1.04	0.0157	B
LAW090 R	0.70	0.29		C	5.80	3.41		C	0.09	0.10		C
LAW090 N	0.32	0.21	0.0192	C	2.43	2.64	0.1245	C	0.04	0.04	0.4574	BC
LAW118 R	0.40	0.14		C	2.93	0.54		C	0.14	0.11		BC
LAW118 N	0.97	0.33	0.0003	C	7.00	3.25	0.0003	C	0.45	0.24	0.0004	BC
Number of sites R & N differences			7	2			2	1			3	1

Table A98 (cont.). Condensed bulk parameters.												
	Total d13C				Total d15N				Leached d13C			
Sample Name	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey
BGP R	-22.88	0.82		B	7.20	0.93		C	-26.89	7.79		A
BGP N	-23.66	0.72	0.0947	B	5.90	1.23	0.0362	BC	-28.49	2.12	0.9105	A
BIS097 R	-22.75	0.68		B	5.27	0.85		BC	-24.19	1.98		A
BIS097 N	-20.08	2.19	0.0028	BC	5.22	1.16	0.9341	BC	2.28	23.67	0.4063	A
BLK016 R	-7.74	1.55		A	5.30	1.19		BC	-63.20	74.58		A
BLK016 N	-15.58	4.77	0.0002	C	6.73	1.80	0.0847	C	-42.53	39.29	0.5788	A
FSL201 R	-20.60	1.91		B	5.63	1.49		C	-22.11	9.72		A
FSL201 N	-18.91	3.21	0.2026	BC	7.40	2.04	0.0636	C	-20.89	5.23	0.7682	A
IND105 R	-14.95	2.70		C	7.18	1.30		C	-15.05	-15.05		A
IND105 N	-10.85	1.47	0.0074	AC	10.08	1.40	0.0014	A	-17.66	0.46	0.1503	A
IND123 R	-15.96	2.14		C	6.57	2.99		C	-26.19	10.15		A
IND123 N	-17.77	1.79	0.1277	BC	11.18	0.54	0.0048	A	-24.63	6.84	0.6690	A
IND131 R	-17.07	7.43		C	5.73	1.80		C	-44.95	55.56		A
IND131 N	-13.07	3.66	0.2811	C	9.47	1.16	0.0009	A	-18.48	7.68	0.4830	A
LAW082 R	-9.73	3.01		A	5.03	1.18		B	-7.13	12.72		A
LAW082 N	-19.84	3.02	0.0000	BC	4.47	2.30	0.5343	BC	-33.71	10.00	0.0000	A
LAW090 R	-8.95	2.12		A	2.89	1.03		B	-10.59	16.01		A
LAW090 N	-5.33	2.34	0.0092	A	5.19	1.95	0.0086	BC	-21.59	23.22	0.8828	A
LAW118 R	-8.97	1.86		A	4.02	1.50		BC	-16.21	8.38		A
LAW118 N	-16.30	1.45	0.0000	C	5.70	1.14	0.0460	BC	-27.21	6.14	0.0007	A
Number of sites R & N differences			6	3			6	3			2	0

Table A98 (cont.). Condensed bulk parameters.												
	Leached d15N				Organic d13C				Organic d15N			
Sample Name	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey	Mean	StDev	Fstat	Tukey
BGP R	15.39	15.41		A	-23.33	0.92		A	7.22	1.17		B
BGP N	11.10	9.70	0.5781	A	-24.92	0.56	0.0035	A	4.83	2.51	0.0222	B
BIS097 R	4.91	6.28		A	-22.95	0.72		A	5.43	1.09		B
BIS097 N	-3.04	8.69	0.1130	A	-20.31	2.24	0.0035	A	5.56	1.34	0.8380	B
BLK016 R	-14.75	19.12		A	-26.06	5.41		A	5.35	1.31		B
BLK016 N	3.90	7.88	0.1564	A	-22.26	2.04	0.7929	A	6.39	2.15	0.2600	B
FSL201 R	-0.53	8.63		A	-23.00	1.22		A	6.18	2.06		B
FSL201 N	-5.85	36.97	0.6981	A	-23.33	3.87	0.8036	A	6.38	2.39	0.8635	B
IND105 R	-5.18	-5.18		A	-26.01	5.99		A	6.96	1.49		B
IND105 N	-27.42	13.63	0.0582	A	-21.51	0.90	0.1237	A	10.03	1.65	0.0028	B
IND123 R	-132.02	330.14		A	-22.68	5.79		A	6.73	3.19		B
IND123 N	6.93	1.38	0.4633	A	-28.33	16.10	0.3263	A	10.86	0.80	0.0142	B
IND131 R	-1.26	10.41		A	-22.08	3.48		A	5.90	2.27		B
IND131 N	-42.16	52.38	0.0551	A	-20.25	1.68	0.2888	A	9.14	1.67	0.0137	B
LAW082 R	-11.27	38.30		A	-22.73	6.98		A	2.86	9.04		A
LAW082 N	-2.12	13.93	0.6752	A	-23.48	1.65	0.3264	A	4.77	2.57	0.6561	B
LAW090 R	-250.69	580.60		A	-19.30	7.26		A	2.99	1.99		A
LAW090 N	-34.86	55.85	0.5403	A	-35.71	19.51	0.2543	A	6.75	2.49	0.0066	B
LAW118 R	-79.60	137.61		A	-24.80	14.79		A	-2.56	6.93		A
LAW118 N	-0.63	3.45	0.4567	A	-24.86	2.74	0.9934	A	4.43	1.74	0.0466	B
Number of sites R & N differences			0	0			2	0			6	3

ANOVA summary

Table A99. Anova single factor summary					
Comparisons	Groups	Count	Sum	Average	Variance
Silt v. Carbon	10	150	2666	17.77333	196.7
Silt v. Carbon	19.80730621	150	5365.286	35.76857	860.6199
Silt v d13C	10	150	2666	17.77333	196.7
Silt v d13C	-23.759	150	-2298.18	-15.3212	36.85794
Silt v. Nitrogen	10	150	2666	17.77333	196.7
Silt v. Nitrogen	2.157409985	150	321.7415	2.144943	3.037198
Silt v. d15N	10	150	2666	17.77333	196.7
Silt v. d15N	5.531	150	856.487	5.709913	8.569718
Clay v. Carbon	18	150	2120	14.13333	29.40492
Clay v. Carbon	19.80730621	150	5365.286	35.76857	860.6199
Clay v d13C	18	150	2120	14.13333	29.40492
Clay v d13C	-23.759	150	-2298.18	-15.3212	36.85794
Clay v. Nitrogen	18	150	2120	14.13333	29.40492
Clay v. Nitrogen	2.157409985	150	321.7415	2.144943	3.037198
Clay v. d15N	18	150	2120	14.13333	29.40492
Clay v. d15N	5.531	150	856.487	5.709913	8.569718
Biomass v. Carbon	2556.662022	150	468114.4	3120.763	20215292
Biomass v. Carbon	19.80730621	150	5365.286	35.76857	860.6199
Biomass v d13C	2556.662022	150	468114.4	3120.763	20215292
Biomass v d13C	-23.759	150	-2298.18	-15.3212	36.85794
Biomass v. Nitrogen	2556.662022	150	468114.4	3120.763	20215292
Biomass v. Nitrogen	2.157409985	150	321.7415	2.144943	3.037198
Biomass v. d15N	2556.662022	150	468114.4	3120.763	20215292
Biomass v. d15N	5.531	150	856.487	5.709913	8.569718
R Silt v. Carbon	10	99	1872	18.90909	231.1243
R Silt v. Carbon	19.80730621	99	3083.691	31.1484	561.8351
R Silt v d13C	10	99	1872	18.90909	231.1243
R Silt v d13C	-23.759	99	-1472.24	-14.8711	39.44487
R Silt v. Nitrogen	10	99	1872	18.90909	231.1243
R Silt v. Nitrogen	2.157409985	99	176.5533	1.783367	1.276138
R Silt v. d15N	10	99	1872	18.90909	231.1243
R Silt v. d15N	5.531	99	492.377	4.973505	7.896432
R Clay v. Carbon	18	99	1454	14.68687	29.89074
R Clay v. Carbon	19.80730621	99	3083.691	31.1484	561.8351
R Clay v d13C	18	99	1454	14.68687	29.89074
R Clay v d13C	-23.759	99	-1472.24	-14.8711	39.44487

Table A99 (cont.). Anova single factor summary					
Comparisons	Groups	Count	Sum	Average	Variance
R Clay v. Nitrogen	18	99	1454	14.68687	29.89074
R Clay v. Nitrogen	2.157409985	99	176.5533	1.783367	1.276138
R Clay v. d15N	18	99	1454	14.68687	29.89074
R Clay v. d15N	5.531	99	492.377	4.973505	7.896432
R Biomass v. Carbon	2556.662022	99	102615.8	1036.523	1405916
R Biomass v. Carbon	19.80730621	99	3083.691	31.1484	561.8351
R Biomass v d13C	2556.662022	99	102615.8	1036.523	1405916
R Biomass v d13C	-23.759	99	-1472.24	-14.8711	39.44487
R Biomass v. Nitrogen	2556.662022	99	102615.8	1036.523	1405916
R Biomass v. Nitrogen	2.157409985	99	176.5533	1.783367	1.276138
R Biomass v. d15N	2556.662022	99	102615.8	1036.523	1405916
R Biomass v. d15N	5.531	99	492.377	4.973505	7.896432
N Silt v. Carbon	6	50	788	15.76	126.3086
N Silt v. Carbon	21.05507225	50	2260.54	45.21079	1354.796
N Silt v d13C	6	50	788	15.76	126.3086
N Silt v d13C	-22.736	50	-803.201	-16.064	31.09412
N Silt v. Nitrogen	6	50	788	15.76	126.3086
N Silt v. Nitrogen	2.054865895	50	143.1333	2.862666	5.893339
N Silt v. d15N	6	50	788	15.76	126.3086
N Silt v. d15N	6.052	50	358.058	7.16116	7.018926
N Clay v. Carbon	10	50	656	13.12	27.61796
N Clay v. Carbon	21.05507225	50	2260.54	45.21079	1354.796
N Clay v d13C	10	50	656	13.12	27.61796
N Clay v d13C	-22.736	50	-803.201	-16.064	31.09412
N Clay v. Nitrogen	10	50	656	13.12	27.61796
N Clay v. Nitrogen	2.054865895	50	143.1333	2.862666	5.893339
N Clay v. d15N	10	50	656	13.12	27.61796
N Clay v. d15N	6.052	50	358.058	7.16116	7.018926
N Biomass v. Carbon	7345.812088	50	358152.8	7163.056	32844484
N Biomass v. Carbon	21.05507225	50	2260.54	45.21079	1354.796
N Biomass v d13C	7345.812088	50	358152.8	7163.056	32844484
N Biomass v d13C	-22.736	50	-803.201	-16.064	31.09412
N Biomass v. Nitrogen	7345.812088	50	358152.8	7163.056	32844484
N Biomass v. Nitrogen	2.054865895	50	143.1333	2.862666	5.893339
N Biomass v. d15N	7345.812088	50	358152.8	7163.056	32844484
N Biomass v. d15N	6.052	50	358.058	7.16116	7.018926

Table A100. ANOVA covariance.							
Comparisons	Source of Variation	SS	df	MS	F	P-value	F crit
Silt v. Carbon	Between Groups	24287.15	1	24287.15	45.94096	6.53E-11	3.872856
Silt v. Carbon	Within Groups	157540.7	298	528.6599			
Silt v d13C	Between Groups	82143.48	1	82143.48	703.41	2.03E-80	3.872856
Silt v d13C	Within Groups	34800.13	298	116.779			
Silt v. Nitrogen	Between Groups	18318.49	1	18318.49	183.426	6.81E-33	3.872856
Silt v. Nitrogen	Within Groups	29760.84	298	99.86858			
Silt v. d15N	Between Groups	10914.46	1	10914.46	106.3426	1.6E-21	3.872856
Silt v. d15N	Within Groups	30585.18	298	102.6348			
Clay v. Carbon	Between Groups	35106.27	1	35106.27	78.88829	6.33E-17	3.872856
Clay v. Carbon	Within Groups	132613.7	298	445.0124			
Clay v d13C	Between Groups	65067.6	1	65067.6	1963.923	3.4E-133	3.872856
Clay v d13C	Within Groups	9873.167	298	33.13143			
Clay v. Nitrogen	Between Groups	10779.11	1	10779.11	664.5134	7.5E-78	3.872856
Clay v. Nitrogen	Within Groups	4833.876	298	16.22106			
Clay v. d15N	Between Groups	5321.55	1	5321.55	280.2686	8.34E-45	3.872856
Clay v. d15N	Within Groups	5658.221	298	18.98732			
Biomass v. Carbon	Between Groups	7.14E+08	1	7.14E+08	70.61572	1.8E-15	3.872856
Biomass v. Carbon	Within Groups	3.01E+09	298	10108076			
Biomass v d13C	Between Groups	7.38E+08	1	7.38E+08	72.97695	6.88E-16	3.872856
Biomass v d13C	Within Groups	3.01E+09	298	10107665			
Biomass v. Nitrogen	Between Groups	7.29E+08	1	7.29E+08	72.16646	9.57E-16	3.872856
Biomass v. Nitrogen	Within Groups	3.01E+09	298	10107648			
Biomass v. d15N	Between Groups	7.28E+08	1	7.28E+08	72.00155	1.02E-15	3.872856
Biomass v. d15N	Within Groups	3.01E+09	298	10107650			
R Silt v. Carbon	Between Groups	7415.129	1	7415.129	18.70242	2.43E-05	3.88934
R Silt v. Carbon	Within Groups	77710.02	196	396.4797			
R Silt v d13C	Between Groups	56484.52	1	56484.52	417.5237	1.87E-50	3.88934
R Silt v d13C	Within Groups	26515.78	196	135.2846			
R Silt v. Nitrogen	Between Groups	14517.88	1	14517.88	124.9385	9.3E-23	3.88934
R Silt v. Nitrogen	Within Groups	22775.24	196	116.2002			
R Silt v. d15N	Between Groups	9612.927	1	9612.927	80.43593	2.42E-16	3.88934
R Silt v. d15N	Within Groups	23424.03	196	119.5104			
R Clay v. Carbon	Between Groups	13413.6	1	13413.6	45.33722	1.79E-10	3.88934
R Clay v. Carbon	Within Groups	57989.13	196	295.8629			
R Clay v d13C	Between Groups	43246.84	1	43246.84	1247.464	6.4E-87	3.88934
R Clay v d13C	Within Groups	6794.89	196	34.66781			
R Clay v. Nitrogen	Between Groups	8241.768	1	8241.768	528.8798	1.44E-57	3.88934

Table A100 (cont.). ANOVA covariance.							
Comparisons	Source of Variation	SS	df	MS	F	P-value	F crit
R Clay v. Nitrogen	Within Groups	3054.355	196	15.58344			
R Clay v. d15N	Between Groups	4670.297	1	4670.297	247.1895	1.43E-36	3.88934
R Clay v. d15N	Within Groups	3703.143	196	18.89359			
R Biomass v. Carbon	Between Groups	50033528	1	50033528	71.14725	7.18E-15	3.88934
R Biomass v. Carbon	Within Groups	1.38E+08	196	703239.1			
R Biomass v d13C	Between Groups	54718776	1	54718776	77.83854	6.16E-16	3.88934
R Biomass v d13C	Within Groups	1.38E+08	196	702977.9			
R Biomass v. Nitrogen	Between Groups	52998975	1	52998975	75.39414	1.5E-15	3.88934
R Biomass v. Nitrogen	Within Groups	1.38E+08	196	702958.8			
R Biomass v. d15N	Between Groups	52672684	1	52672684	74.92962	1.78E-15	3.88934
R Biomass v. d15N	Within Groups	1.38E+08	196	702962.1			
N Silt v. Carbon	Between Groups	21683.73	1	21683.73	29.28048	4.44E-07	3.938112
N Silt v. Carbon	Within Groups	72574.13	98	740.5523			
N Silt v d13C	Between Groups	25319.21	1	25319.21	321.7125	1.02E-32	3.938112
N Silt v d13C	Within Groups	7712.732	98	78.70135			
N Silt v. Nitrogen	Between Groups	4158.531	1	4158.531	62.91181	3.55E-12	3.938112
N Silt v. Nitrogen	Within Groups	6477.894	98	66.10096			
N Silt v. d15N	Between Groups	1848.501	1	1848.501	27.72873	8.26E-07	3.938112
N Silt v. d15N	Within Groups	6533.047	98	66.66375			
N Clay v. Carbon	Between Groups	25745.47	1	25745.47	37.24712	2.09E-08	3.938112
N Clay v. Carbon	Within Groups	67738.29	98	691.207			
N Clay v d13C	Between Groups	21292.68	1	21292.68	725.3252	4.36E-47	3.938112
N Clay v d13C	Within Groups	2876.892	98	29.35604			
N Clay v. Nitrogen	Between Groups	2630.323	1	2630.323	156.9813	4.56E-22	3.938112
N Clay v. Nitrogen	Within Groups	1642.054	98	16.75565			
N Clay v. d15N	Between Groups	887.6944	1	887.6944	51.25717	1.5E-10	3.938112
N Clay v. d15N	Within Groups	1697.207	98	17.31844			
N Biomass v. Carbon	Between Groups	1.27E+09	1	1.27E+09	77.12349	5.3E-14	3.938112
N Biomass v. Carbon	Within Groups	1.61E+09	98	16422919			
N Biomass v d13C	Between Groups	1.29E+09	1	1.29E+09	78.46022	3.63E-14	3.938112
N Biomass v d13C	Within Groups	1.61E+09	98	16422258			
N Biomass v. Nitrogen	Between Groups	1.28E+09	1	1.28E+09	78.04713	4.08E-14	3.938112
N Biomass v. Nitrogen	Within Groups	1.61E+09	98	16422245			
N Biomass v. d15N	Between Groups	1.28E+09	1	1.28E+09	77.95344	4.19E-14	3.938112
N Biomass v. d15N	Within Groups	1.61E+09	98	16422246			

Table A101. Multiple ANOVA P-value summary for carbon and nitrogen.		
Bulk Parameter	10 groups R together with N P-value	20 groups R separate from N P-value
loss on ignition	1.13E-31	5.69E-30
total carbon	2.80E-30	3.46E-29
total nitrogen	2.52E-17	2.52E-18
leachable carbon	**2.74E-01**	8.71E-03
leachable nitrogen	**6.37E-02**	5.48E-08
organic carbon	2.03E-08	7.02E-17
organic nitrogen	2.10E-18	3.09E-25

Table A102. Multiple ANOVA P-value summary for soil texture.		
Bulk Parameter	10 groups R together with N P-value	20 groups R separate from N P-value
sand	1.13E-31	5.69E-30
silt	2.80E-30	3.46E-29
clay	2.52E-17	2.52E-18

Table A103. Multiple ANOVA P-value summary for carbon and nitrogen isotopes.		
Bulk Parameter	10 groups R together with N P-value	20 groups R separate from N P-value
total $\delta^{13}C$	1.75E-26	2.44E-36
total $\delta^{15}N$	6.57E-11	7.02E-19
leachable $\delta^{13}C$	5.11E-03	**3.46E-01**
leachable $\delta^{15}N$	**4.79E-01**	**7.96E-01**
organic $\delta^{13}C$	**9.35E-01**	**1.78E-01**
organic $\delta^{15}N$	8.68E-08	5.36E-09

Table A104. Multiple ANOVA P-value summary for lipids.		
Bulk Parameter	10 groups R together with N P-value	20 groups R separate from N P-value
total PLFA	**1.09E-01**	3.75E-24
total sterols	1.86E-02	4.59E-22

Misclassification matrices

Table A105. Misclassification matrix for the SIMCA model derived to differentiate soils from the ten parcel locations for all data.

	Pred1	Pred2	Pred3	Pred4	Pred5	Pred6	Pred7	Pred8	Pred9	Pred10
Actual1	6	3	0	3	0	0	0	3	0	0
Actual2	0	12	0	2	0	0	0	0	0	1
Actual3	0	0	13	0	1	0	0	0	0	0
Actual4	2	3	0	8	0	1	0	1	0	1
Actual5	0	0	0	0	12	0	3	0	0	0
Actual6	1	1	1	3	2	5	1	1	0	0
Actual7	0	0	0	0	3	0	12	0	0	0
Actual8	2	1	0	0	0	1	0	9	0	0
Actual9	0	0	0	0	0	0	0	0	13	1
Actual10	0	0	0	1	0	3	0	1	2	8

Table A106. Misclassification matrix for the SIMCA model derived to best separate the ten parcel locations using soil characteristic data only for soils supporting native vegetation.

	Pred1	Pred2	Pred3	Pred4	Pred5	Pred6	Pred7	Pred8	Pred9	Pred10
Actual1	5	0	0	0	0	0	0	0	0	0
Actual2	4	0	0	1	0	0	0	0	0	0
Actual3	0	0	0	0	2	0	3	0	0	0
Actual4	1	0	0	5	0	0	0	0	0	0
Actual5	0	0	0	0	5	0	0	0	0	0
Actual6	0	0	0	2	1	2	0	0	0	0
Actual7	0	0	0	0	3	1	1	0	0	0
Actual8	0	0	0	1	0	0	0	4	0	0
Actual9	1	0	0	0	0	0	0	2	1	0
Actual10	0	0	0	5	0	0	0	0	0	0

Table A107. Interclass distances for the SIMCA model derived to best separate the ten parcel locations using soil characteristic data only for soils supporting native vegetation.

	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10
CS1	0	2.52	11.19	1.06	5.28	1.06	0.98	1.54	1.92	4.94
CS2	2.52	0	8.00E+12	1.43	7.9	1.87	1.39	4.89	5.64	3.00E+12
CS3	11.19	8.00E+12	0	3.67	3.39	1.48	0.54	8.13	12.19	7.00E+12
CS4	1.06	1.43	3.67	0	2.22	1.27	0.78	2.98	5.95	0.37
CS5	5.28	7.9	3.39	2.21	0	0.37	0.4	2.5	2.75	5.32
CS6	1.06	1.87	1.48	1.27	0.37	0	1.07	0.7	6.72	1.58
CS7	0.98	1.39	0.54	0.78	0.4	1.07	0	1.53	8.37	0.81
CS8	1.54	4.89	8.13	2.98	2.5	0.7	1.53	0	1.53	4.71
CS9	1.92	5.64	12.19	5.95	2.75	6.72	8.37	1.53	0	6.13
CS10	4.94	3.00E+12	7.00E+12	0.37	5.32	1.58	0.81	4.71	6.13	0

Table A108. Misclassification matrix for the SIMCA model derived to best separate the ten parcel locations using soil characteristics of samples collected from disturbed sites.

	Pred1	Pred2	Pred3	Pred4	Pred5	Pred6	Pred7	Pred8	Pred9	Pred10
Actual1	6	0	0	3	0	1	0	0	0	0
Actual2	1	9	0	0	0	0	0	0	0	0
Actual3	0	0	9	0	0	0	0	0	0	0
Actual4	0	0	0	9	0	1	0	0	0	0
Actual5	0	0	0	0	9	0	1	0	0	0
Actual6	0	2	0	2	2	3	1	0	0	0
Actual7	0	0	1	0	1	0	8	0	0	0
Actual8	0	0	0	0	0	0	0	8	0	0
Actual9	0	0	0	0	0	0	0	0	9	1
Actual10	0	0	0	0	0	1	0	1	2	6

Table A109. SIMCA interclass distances for the SIMCA model that best differentiated the ten parcel locations using soil characteristics of samples collected from disturbed sites.

	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8	CS9	CS10
CS1	0	1.42	2.74	0.82	2.67	0.23	3.07	6.43	1.42	0.65
CS2	1.42	0	4.33	1.15	4.11	0.67	3.99	11.98	4.4	0.66
CS3	2.74	4.33	0	2.93	0.95	1.04	1.46	5.14	2.09	1.71
CS4	0.82	1.15	2.93	0	2.85	0.29	2.9	3.16	1.32	0.26
CS5	2.67	4.11	0.95	2.85	0	1.25	0.74	4.61	2.53	1.91
CS6	0.23	0.67	1.04	0.29	1.25	0	1.23	3.89	0.5	0.22
CS7	3.07	3.99	1.46	2.9	0.74	1.23	0	3.89	2.5	2.07
CS8	6.43	11.98	5.14	3.16	4.61	3.89	3.89	0	1.19	1.57
CS9	1.42	4.4	2.09	1.32	2.53	0.5	2.5	1.19	0	0.34
CS10	0.65	0.66	1.71	0.26	1.91	0.22	2.07	1.57	0.34	0

Table A110. SIMCA misclassification matrix for all measured soil characteristics with the 1st class disturbed, 2nd class native.

	Pred1	Pred2
Actual1	78	19
Actual2	9	41

Table A111. SIMCA misclassification matrix for all non-rare data with the 1st class disturbed, 2nd class native.

	Pred1	Pred2
Actual1	92	5
Actual2	2	48

Table A112. SIMCA interclass distances for native vs disturbed samples. The distance between the 1st class disturbed and 2nd class native is 1.07.

	CS1	CS2
CS1	0	1.07
CS2	1.07	0

Appendix B. Figures

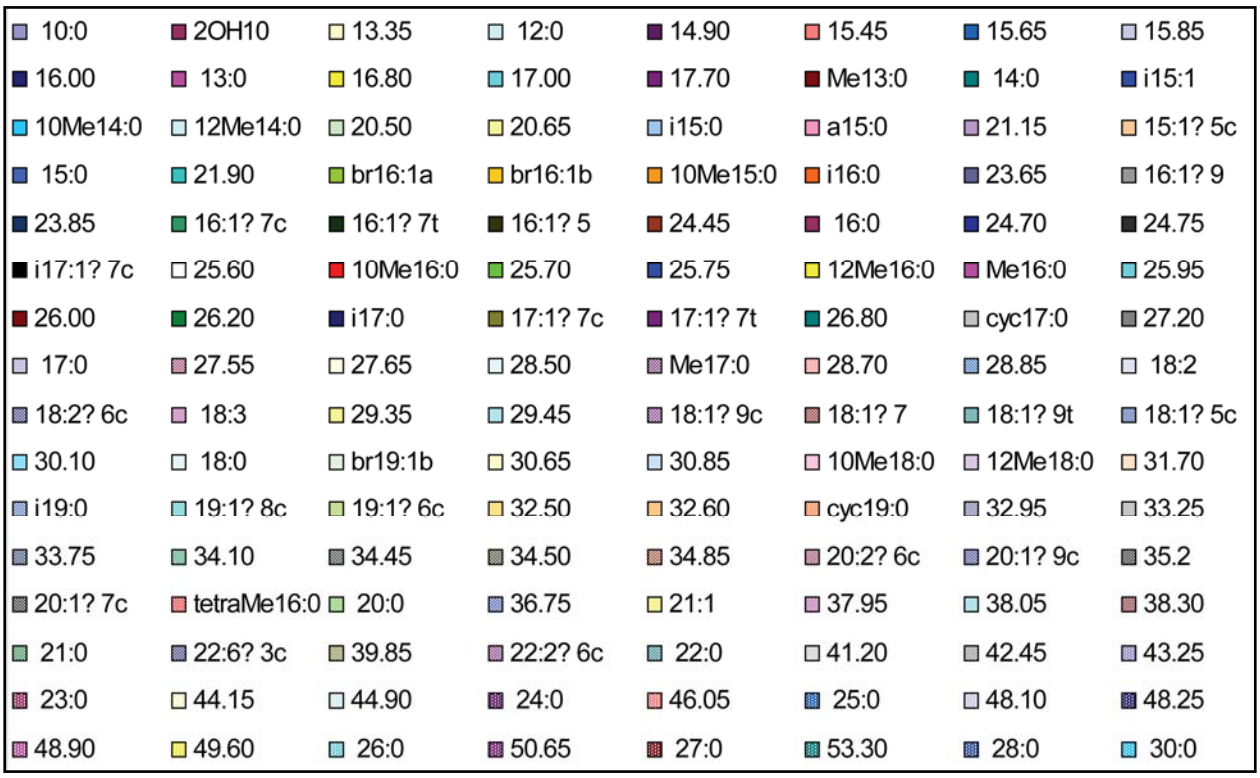

Figure B1. PLFAME legend.

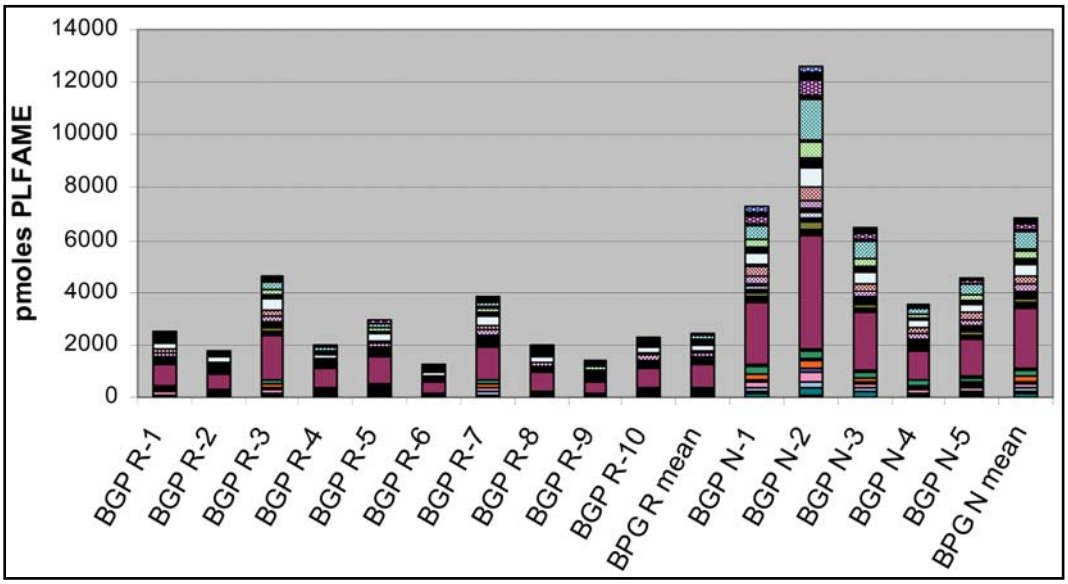

Figure B2. BGP sample comparison for PLFAME.

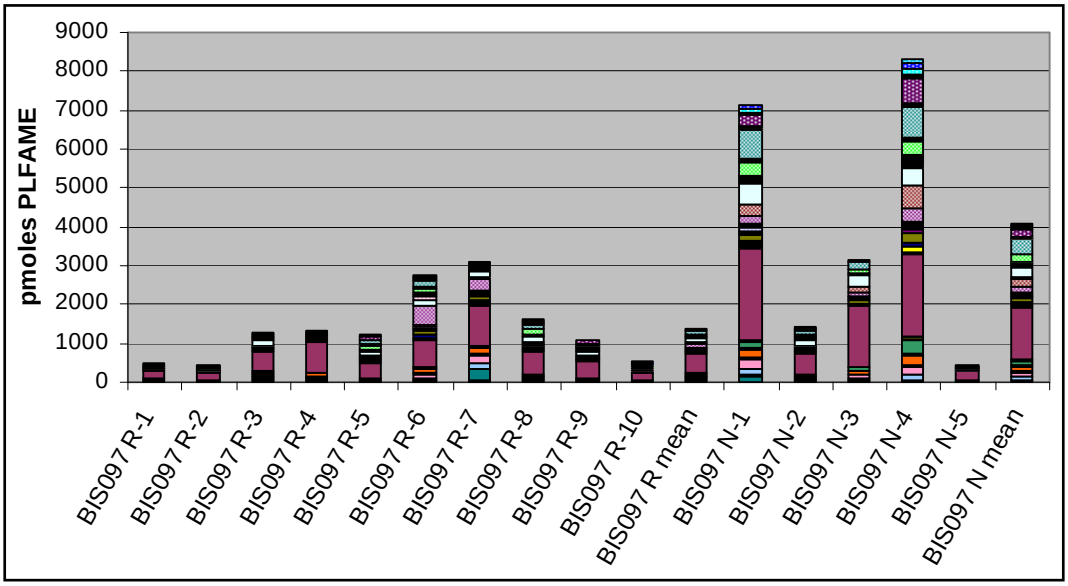

Figure B3. BIS097 sample comparison for PLFAME.

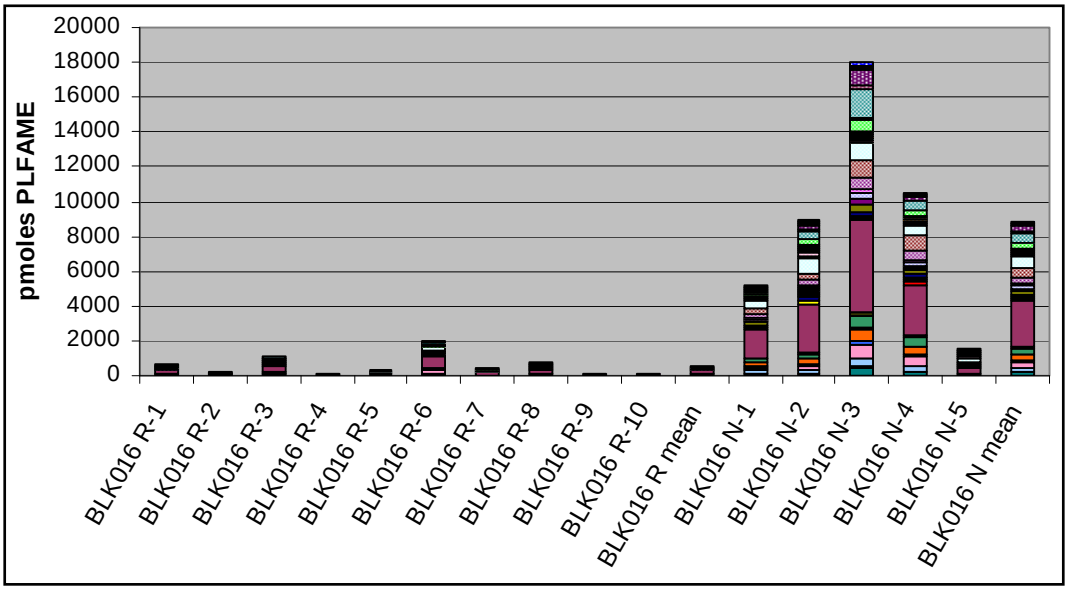

Figure B4.BLK016 sample comparison for PLFAME.

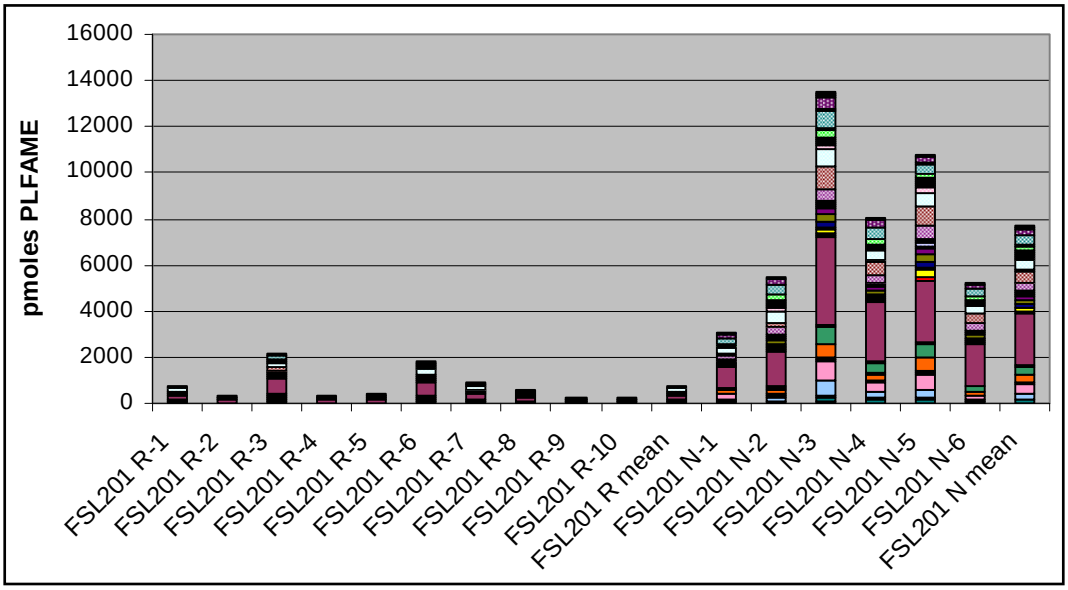

Figure B5. FSL201 sample comparison for PLFAME.

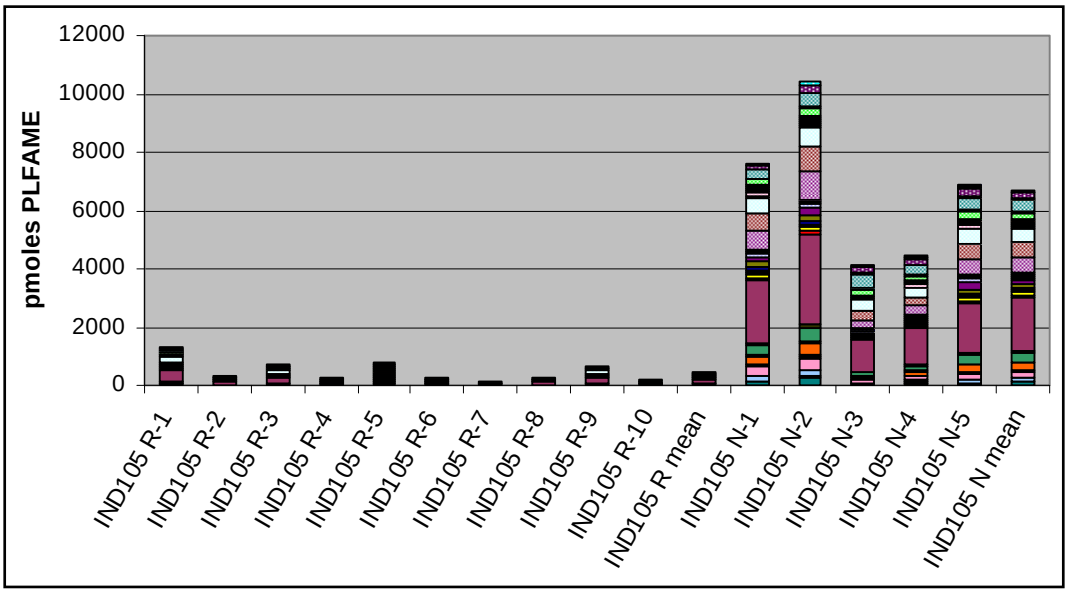

Figure B6. IND105 sample comparison for PLFAME.

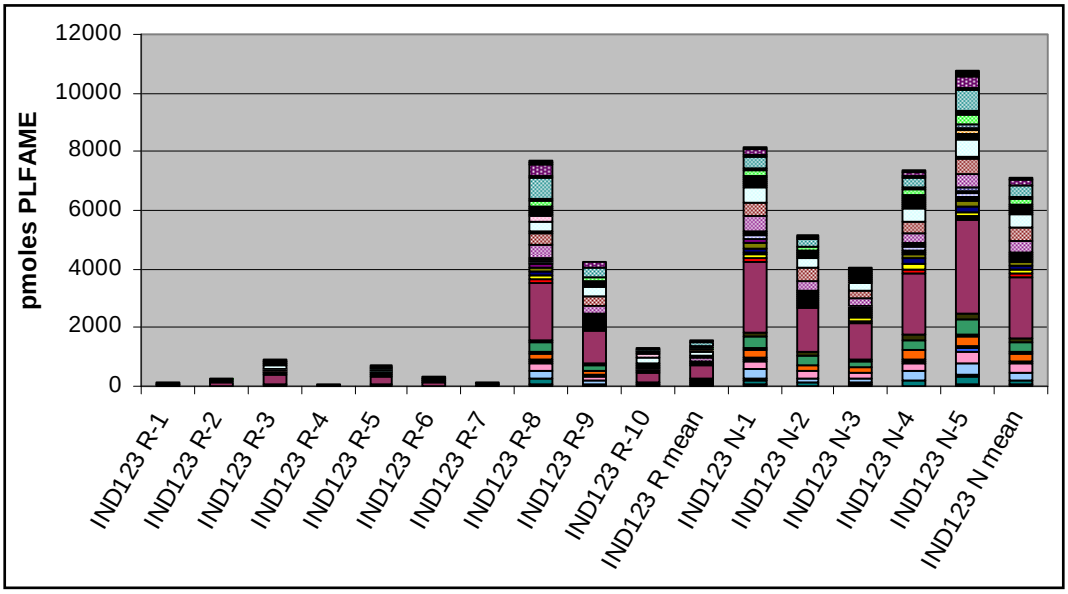

Figure B7. IND123 sample comparison for PLFAME.

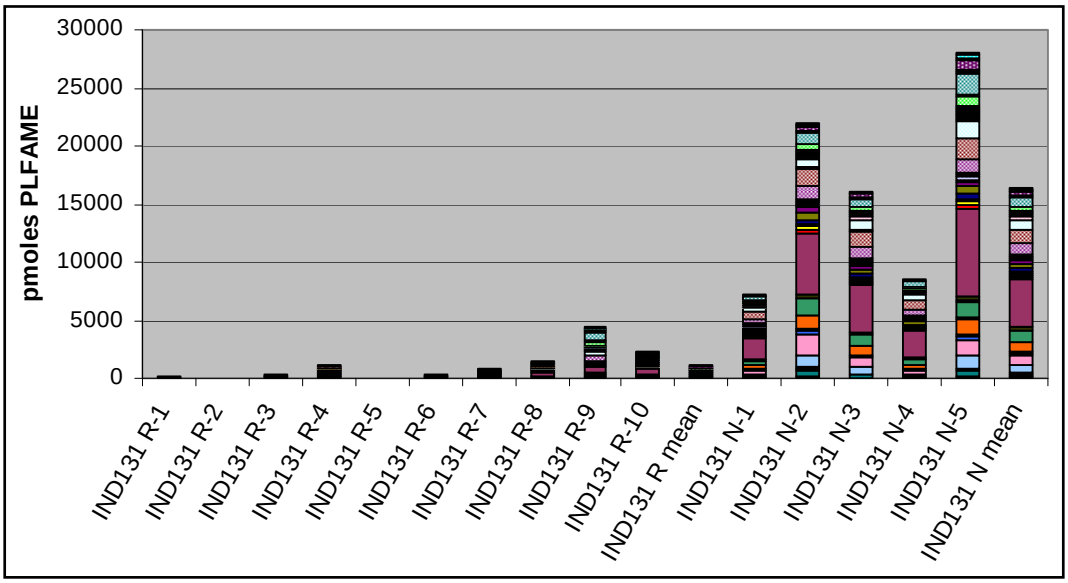

Figure B8. IND131 sample comparison for PLFAME.

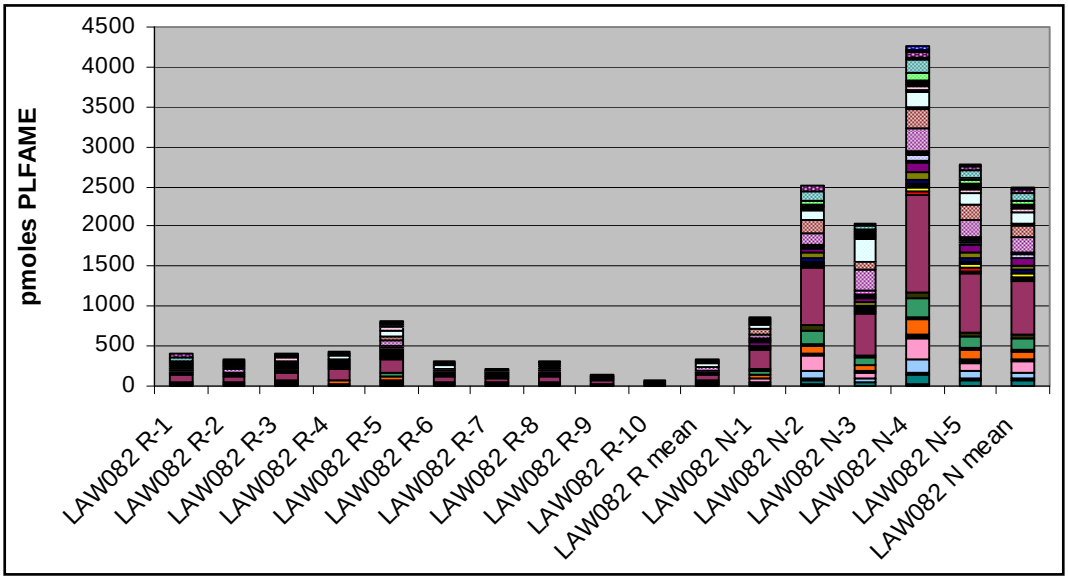

Figure B9. LAW082 sample comparison for PLFAME.

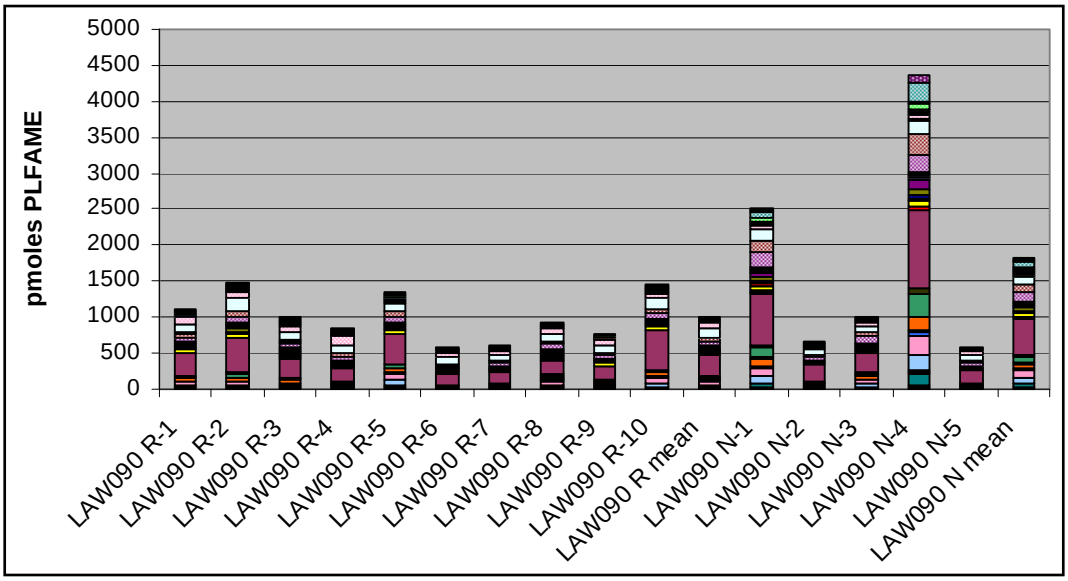

Figure B10. LAW090 sample comparison for PLFAME.

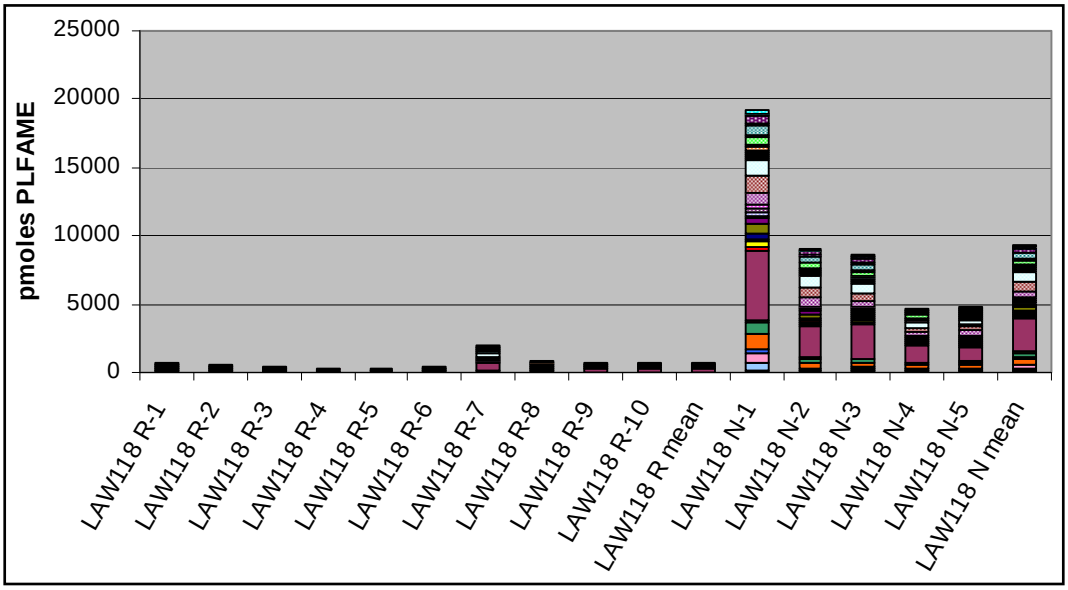

Figure B11. LAW118 sample comparison for PLFAME.

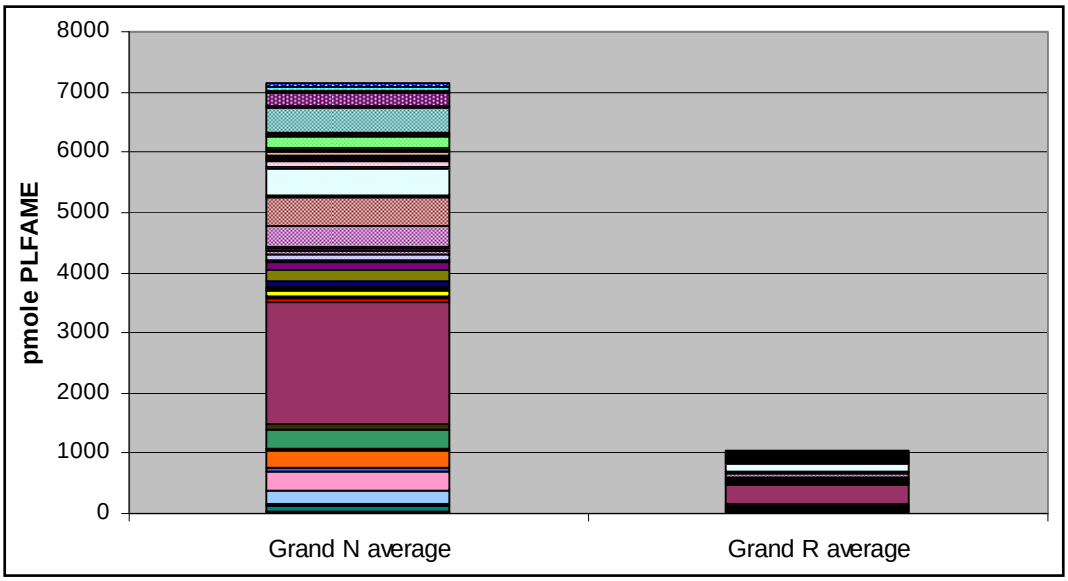

Figure B12. N and R Grand Means-PLFAME.

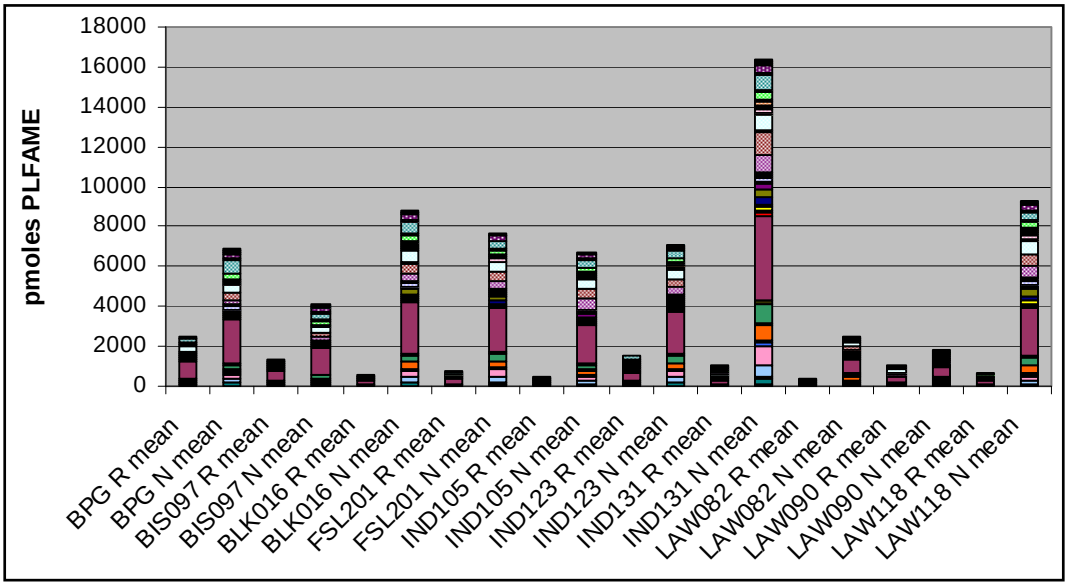

Figure B13. Average levels (pmole PLFAME/gram dry weight) of individual polar lipid fatty acid methyl esters in soils from ten disturbed (R) and five native (N) sites at each of the ten locations.

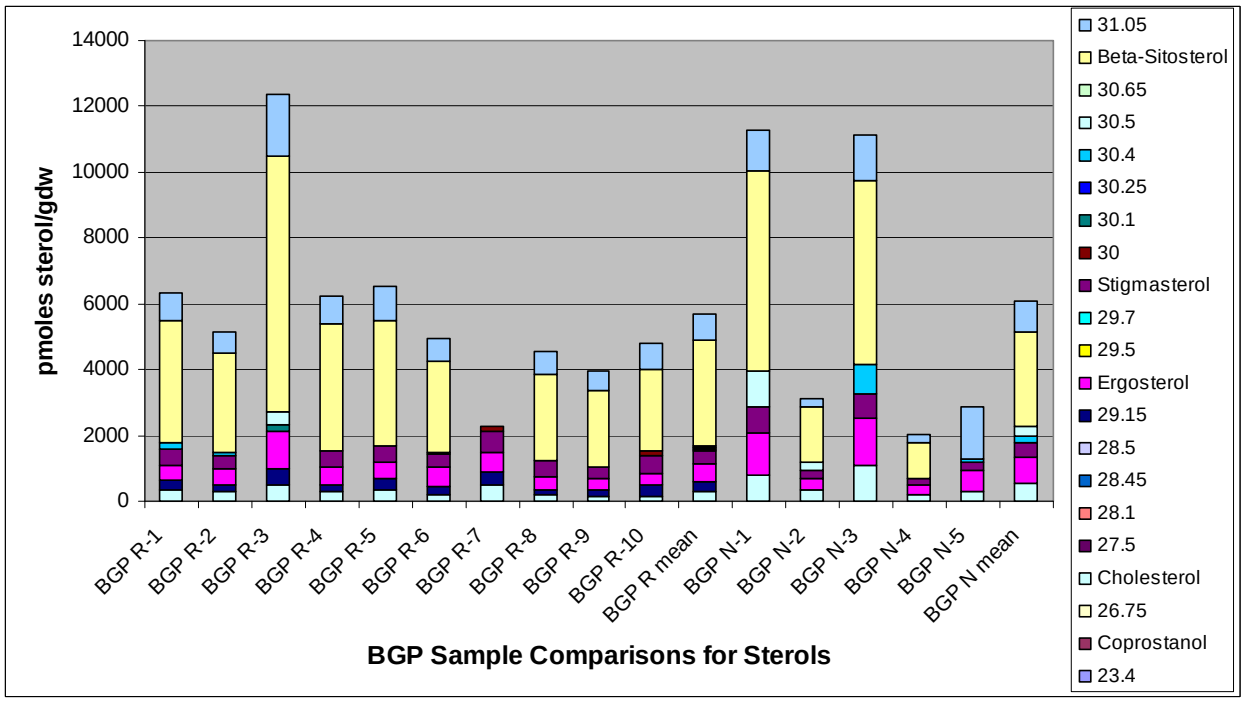

Figure B14. BGP sample comparisons for sterols.

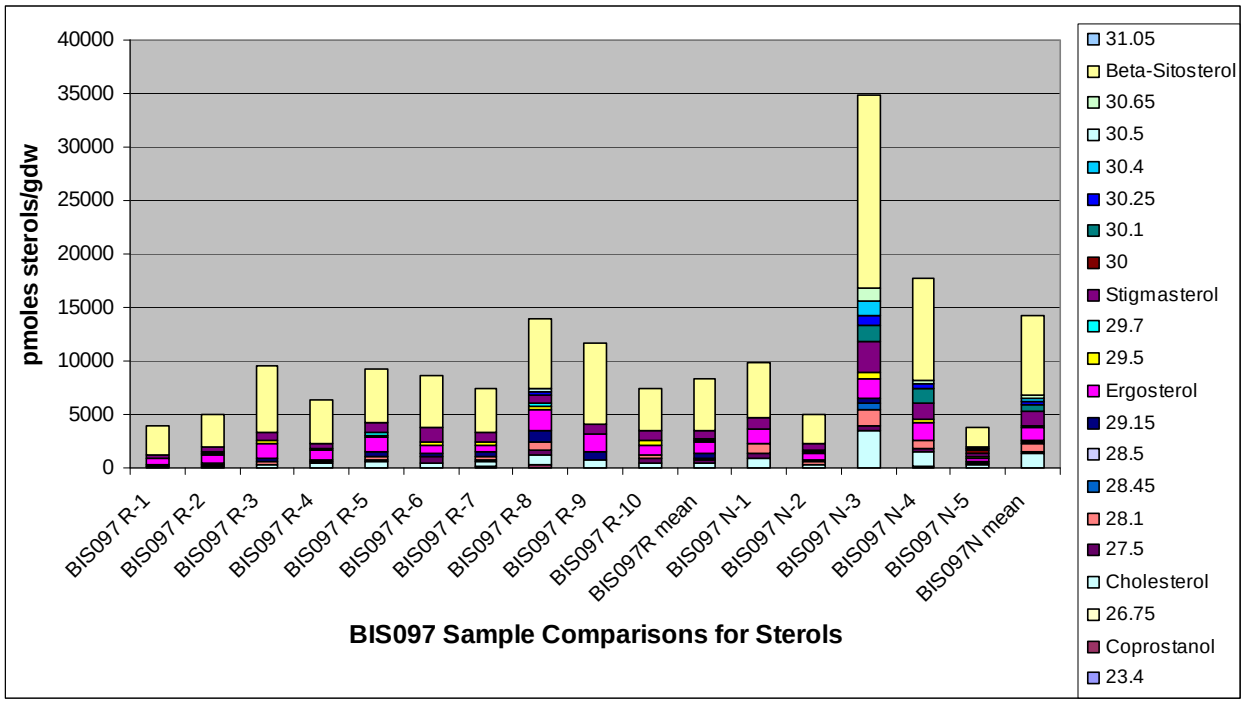

Figure B15. BIS097 sample comparisons for sterols.

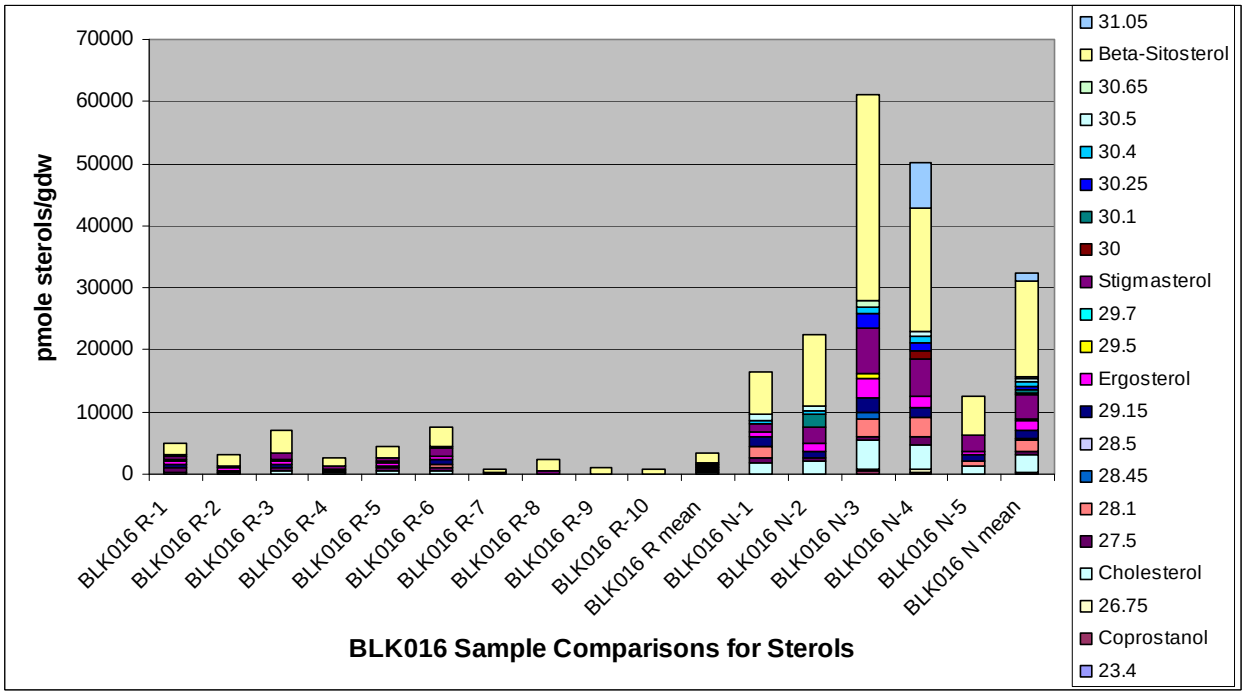

Figure B16. -BLK016 sample comparisons for sterols.

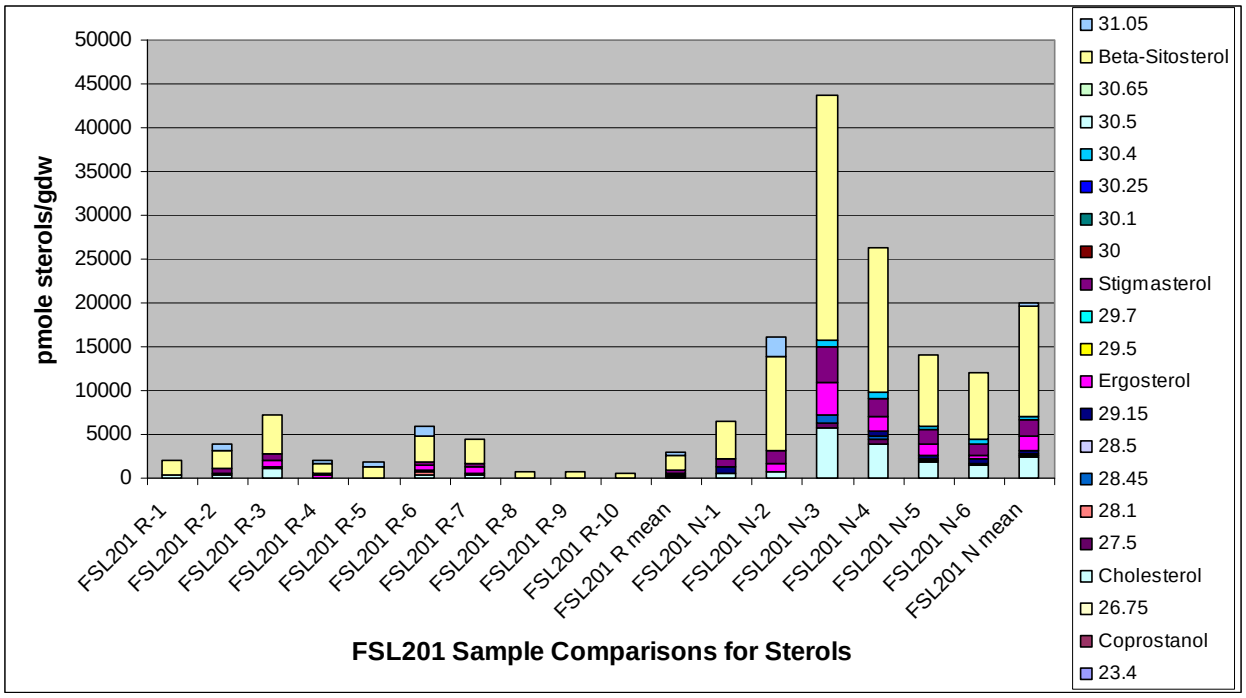

Figure B17. FSL201 sample comparisons for sterols.

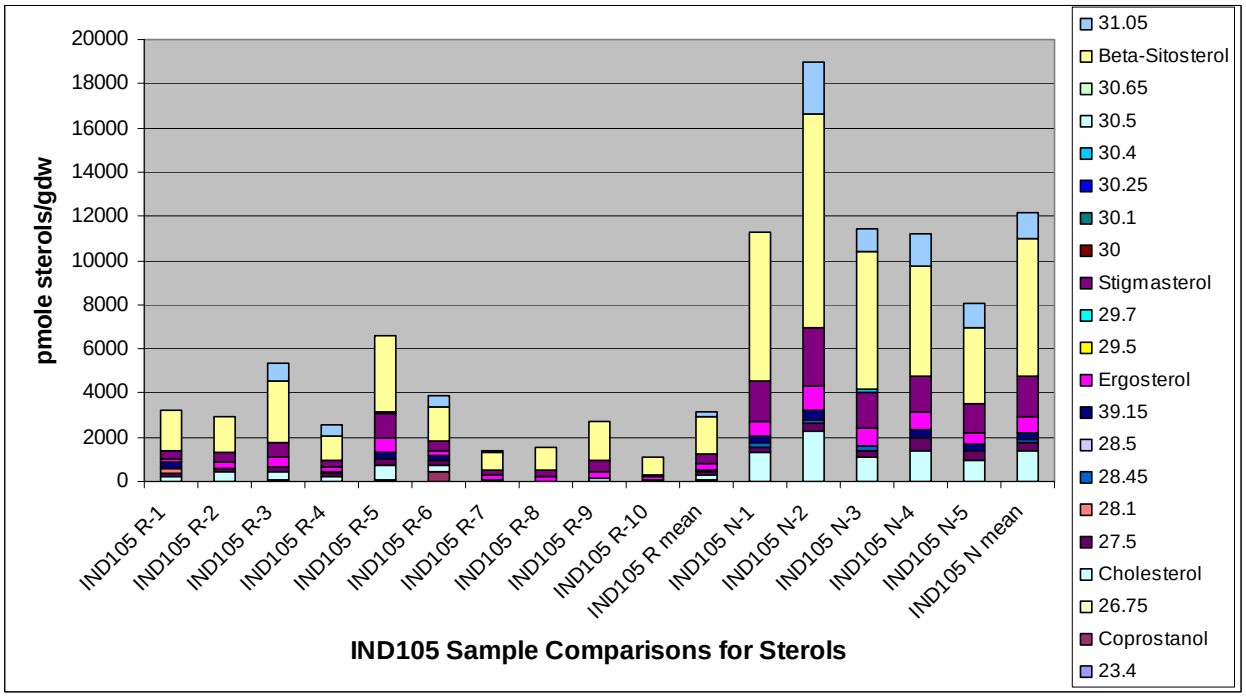

Figure B18. IND105 sample comparisons for sterols.

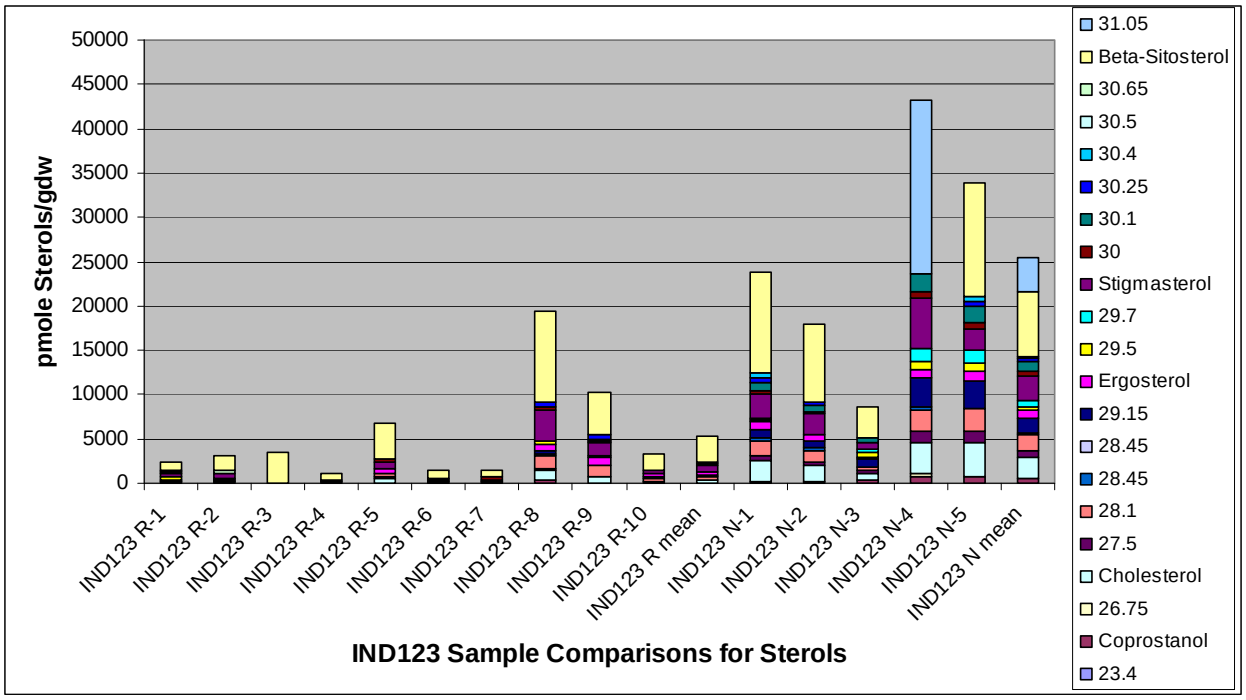

Figure B19. IND123 sample comparisons for sterols.

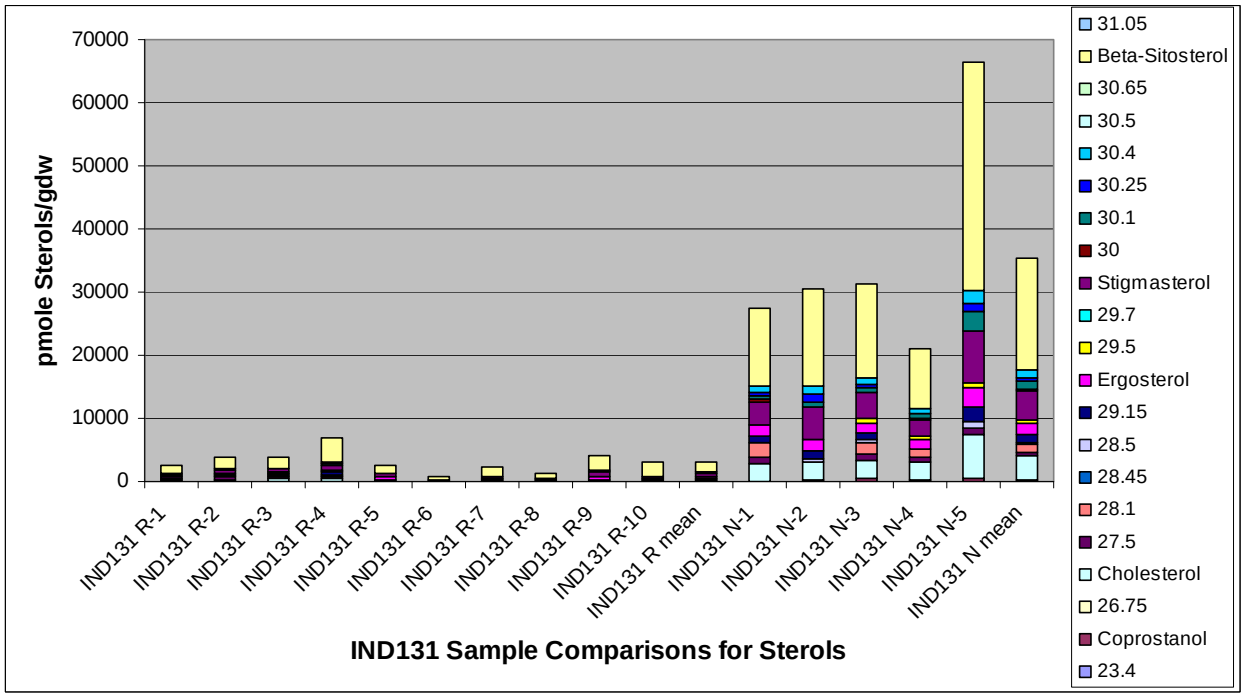

Figure B20. Levels (pmole sterol/gram dry weight) of sterols in soil samples from the ten disturbed and five native sites and their respective averages at the IND131 location.

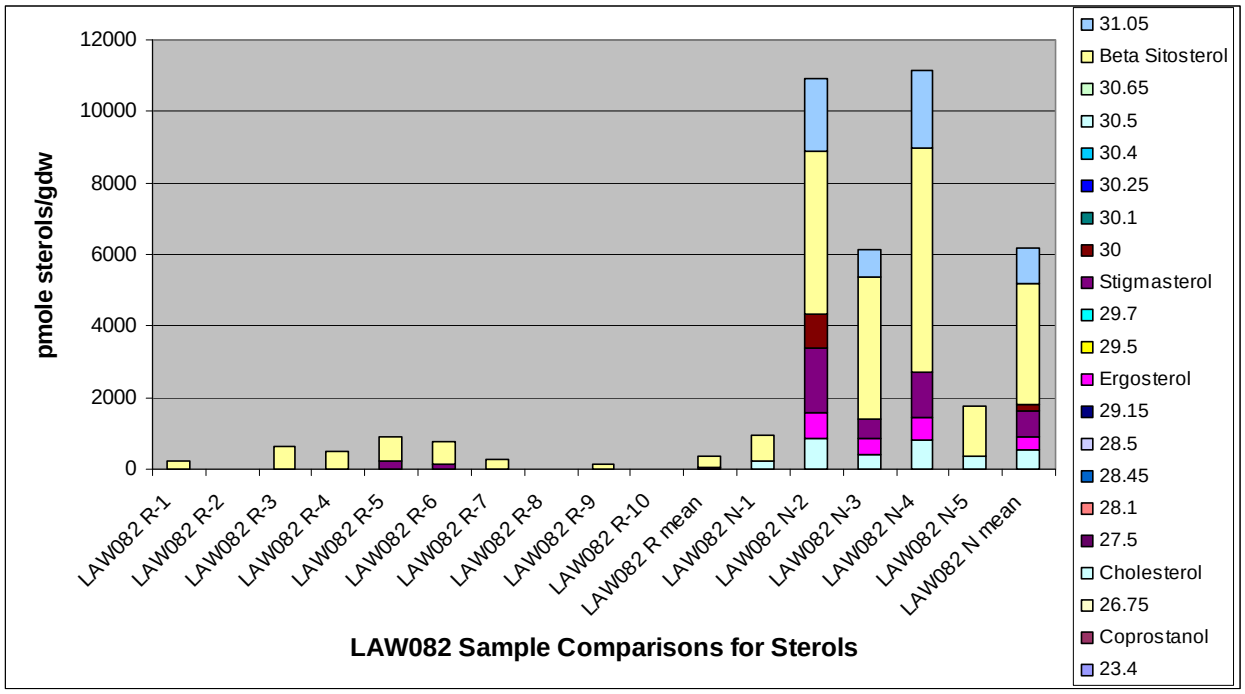

Figure B21. LAW082 sample comparisons for sterols.

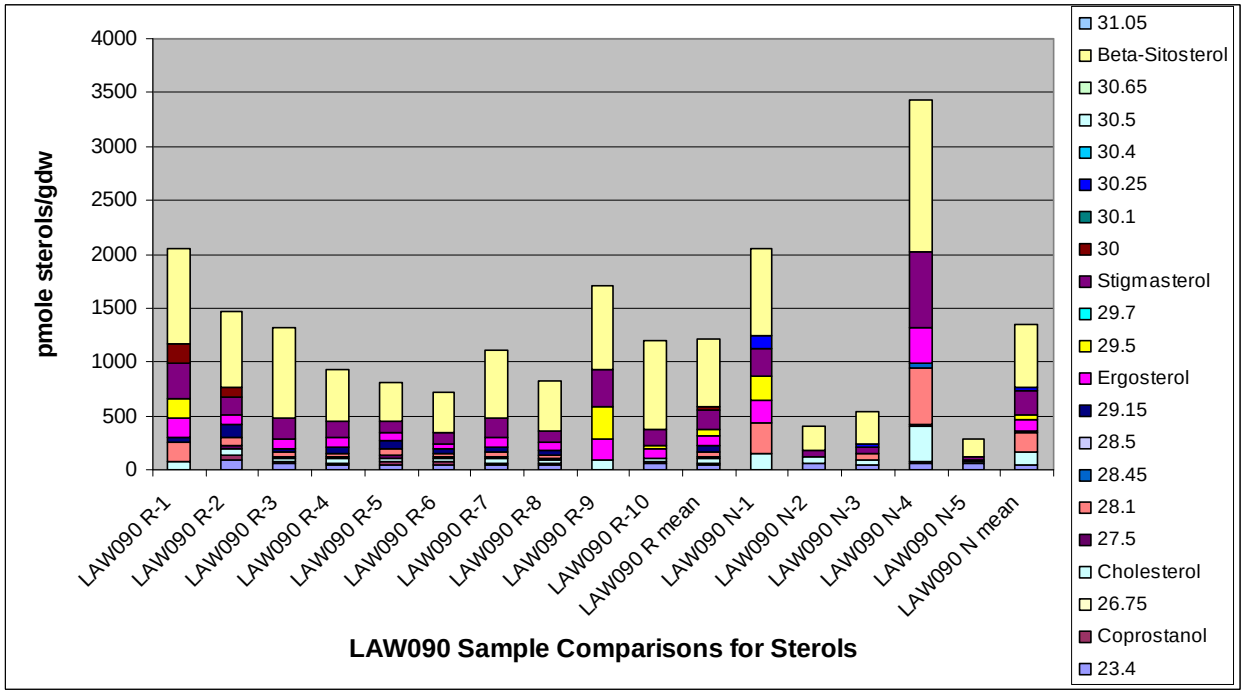

Figure B21. LAW090 sample comparisons for sterols.

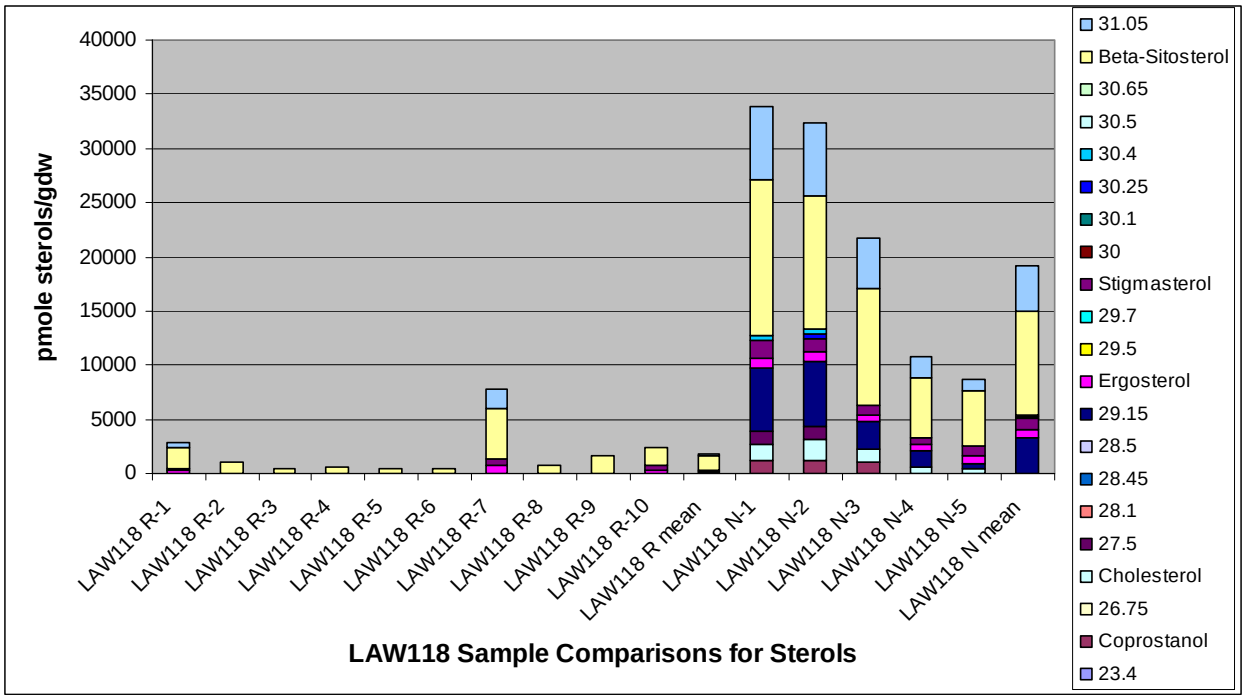

Figure B22. LAW118 sample comparisons for sterols.

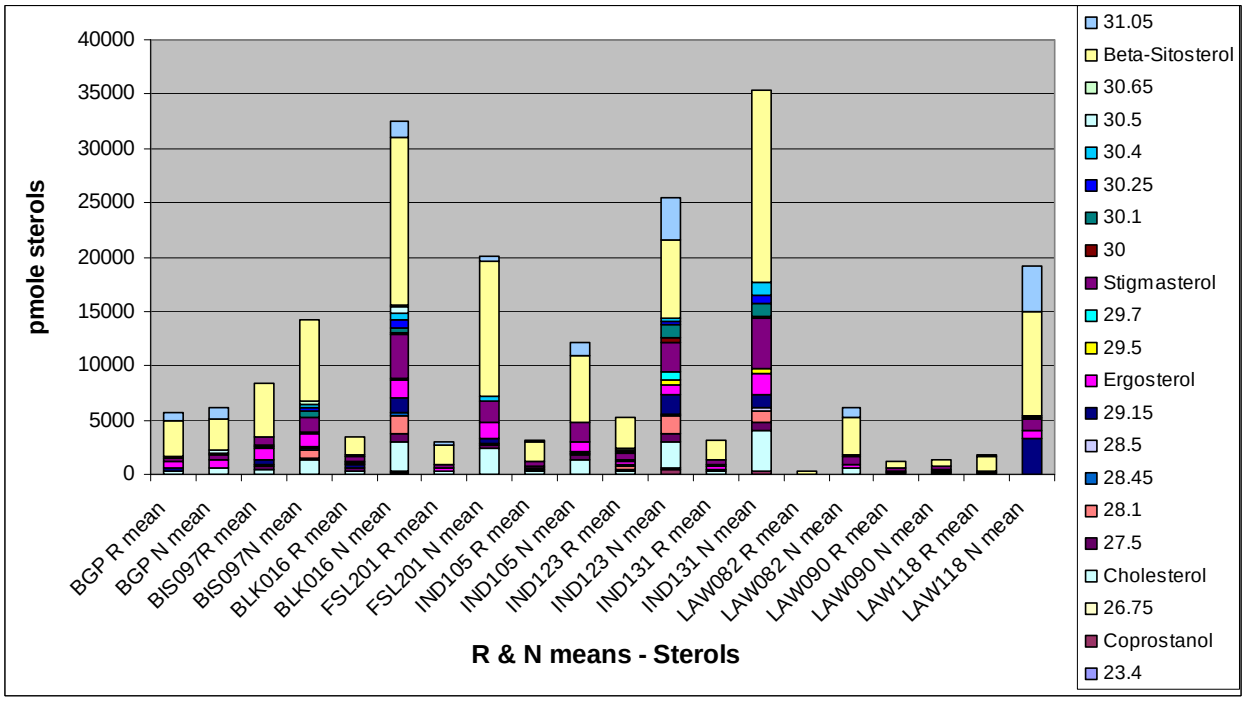

Figure B23. R and N means - Sterols.

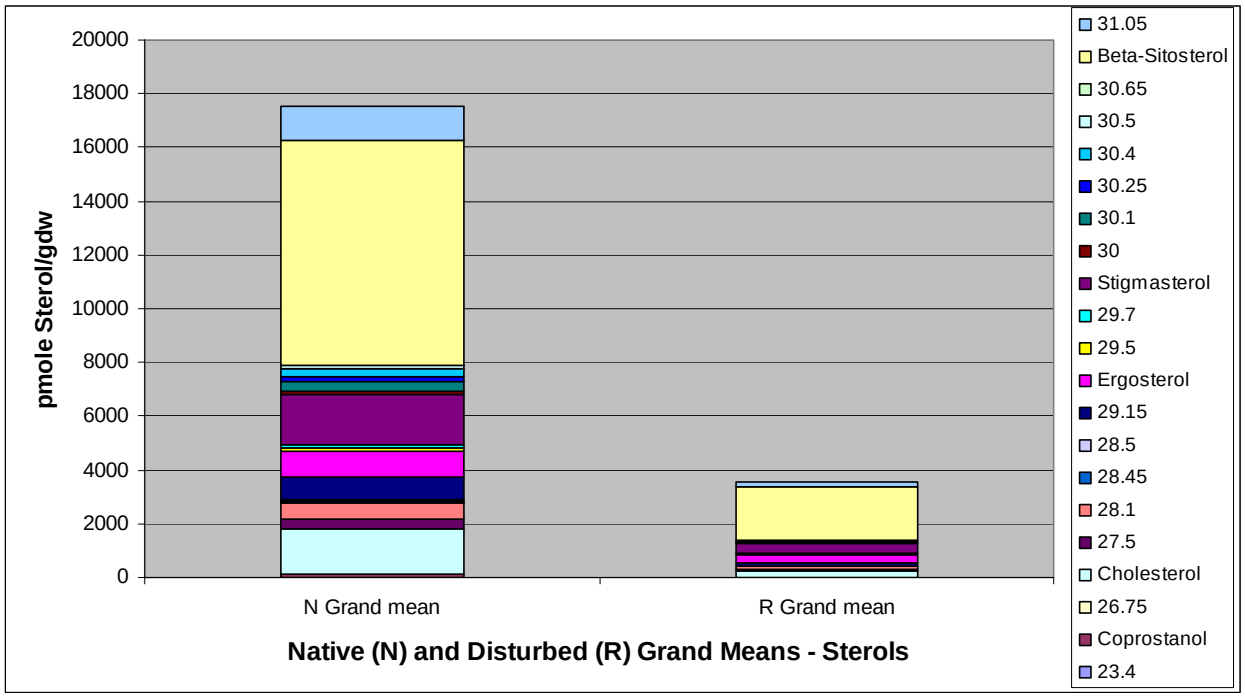

Figure B24. R and N grand means - Sterols.

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14. ABSTRACT

The future quality and quantity of water for Los Angeles, CA, depends on effective environmental management of both water and land use in Owens Valley. Long-term environmental monitoring will be used to assess progress towards attaining sustainable restoration goals. Re-establishment of native plant communities on previously cultivated lands is a major land management goal. Establishment of desired plant communities may, in turn, depend on relationships between soil microorganisms and plants. These interrelationships depend on soil characteristics affecting the microbial communities. This study was designed to provide survey information on microbial communities in soils from native and disturbed areas at ten locations spanning Owens Valley. At each location, five surface soil samples were collected along a 150-m transect through native vegetation, and ten soil samples were collected along a 300-m transect through disturbed areas. Soils were characterized by soil texture, total carbon, total nitrogen, organic carbon, organic nitrogen, leachable carbon, leachable nitrogen, carbon and nitrogen isotopic ratios, microbial community biomass, and lipid profiles of soil microbial community compositions. Analysis of variance, Tukey's test for comparing multiple means, hierarchical cluster analysis, and principal component analysis were used to show differences in soil characteristics. While native and disturbed soil samples were shown to differ in many characteristics, the largest and most frequently shown differences were related to the soil microbial communities. Total soil microbial biomass was significantly and consistently higher in native soils than soils from disturbed areas. Large and significant (cont.)

15. SUBJECT TERMS

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Owens Valley
Soil characteristics
Soil microorganisms

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14. ABSTRACT (cont.)

quantitative differences were also seen in the sterol content of soils supporting native plant and those of disturbed areas. The level of fungal sterol ergosterol was consistently and significantly higher in soils supporting native vegetation than in soils from disturbed areas, indicating mycorrhizae as potentially important plant symbionts. The presence of phytosterols and other unidentified sterols was also higher in the native plant soils. In conclusion, soils supporting native plant communities were most different from those in disturbed areas in characteristics related to soil microbiology.